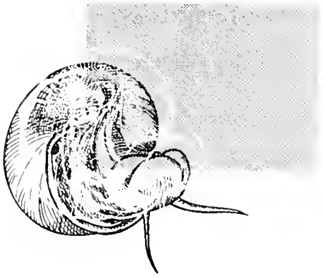
THE FRESHWATER SNAILS

(MOLLUSCA: GASTROPODA)

OF NEW YORK STATE



BY EILEEN H. JOKINEN

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Counties of New York State

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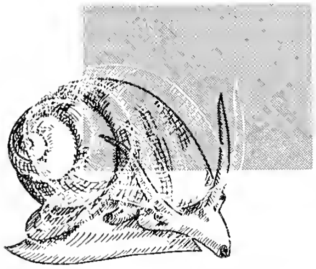

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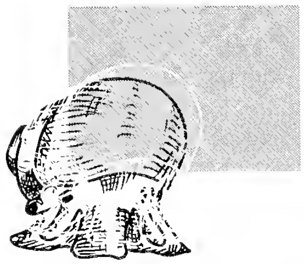
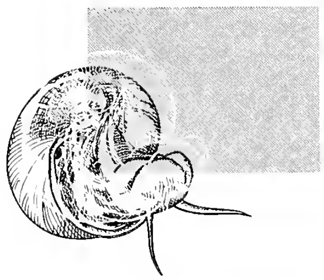


OF NEW YORK STATE



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CONTENTS

INTRODUCTION

The objectives of this research on the freshwater snail fauna of New York State include surveying the State to compile an up-to-date list of species; documenting snail locations relative to geology, the canal system, and watersheds; providing keys for identification; depositing collected specimens in the New York State Museum; providing ecological and habitat information, especially water chemistry parameters, for each species; and reviewing the history of freshwater malacology in the State.

Reviews of the internal anatomy, ecology, physiology, and biology of freshwater gastropods are not presented in this manual because a number of excellent publications are already available on these subjects, e.g., Baker (1928a); Burch (1982, 1989); Russell-Hunter (1983); Fretter & Peake (1975); and Brown (1991). However, summaries of the distributions, historical literature, habitats, and ecology are provided for each species. Also, common names are listed, and most of these are as listed in Turgeon *et al.* (1988), although alternate common names exist (see Clarke 1981).

The keys are artificial and designed to facilitate rapid identification wherever possible. The couplets are illustrated with drawings of pertinent characters, and full illustrations are provided separately. The key to the families precedes the discusssions of the individual species, and each key to species within a family heads the section on that family.

Field sampling of 346 aquatic habitats in New York State and parts of Lake Champlain in Vermont was undertaken during the summers of 1978, 1981, and 1984-1991. Appendix A lists the locations of the sites by number, and Fig. 1 illustrates site locations. In the text that follows, these sites are also given by number.

Ten of the sampled sites yielded no snails. Five of them (Dillon Pond, site number 355; Limekiln Lake, 359; Big Moose Lake, 362; Nicks Lake, 365; and Moss Lake, 413) had pH values of 5.2-6.0, very low conductivities of 23-38 μmhos/cm, and calcium concentrations of 2 ppm or less. It could be assumed that the low calcium concentrations and low buffering capacities of these lakes are the factors causing the lack of snails. A stream, Geyser Brook (267) in Saratoga Springs, had an abundance of stoneflies and mayflies but no snails. The water contained more than sufficient calcium, 35 ppm, but apparently it contains natural radium. Another site, Rushford Lake (414), showed evidence of drawdown. The three remaining sites (364, 418, 419) had no readily perceptible negative features and would have to be examined in greater detail in order to explain the lack of snail populations.

The following native species should be considered as rare or extirpated in New York State: Valvatidae: *Valvata sincera* and *V. lewisi* (both rare); Viviparidae: *Lioplax subcarinata* (extirpated?); Hydrobiidae: *Probythinella lacustris* (extirpated?), *Gillia altilis* (rare), *Birgella subglobosa* (rare); *Cincinnatia cincinnatiensis* (rare), *Pyrgulopsis letsoni* (extirpated or limited to far the western section of the State); Pomatiopsidae: *Pomatiopsis lapidaria* (rare); Pleuroceridae: *Leptoxis carinata* (rare, apparently limited to the Susquehanna watershed); Lymnaeidae: *Lymnaea stagnalis* (rare), *Stagnicola emarginata* (rare), *S. caperata* (rare), *Acella haldemani* (rare), *Bulimnea megasoma* (extirpated), *Fossaria parva* (rare); Planorbidae: *Gyraulus circumstriatus* (rare), *Planorbula armigera* (rare). Several of the pulmonates, e.g., *S. caperata*, *F. parva*, *G. circumstriatus*, and *P. armigera*, tend to inhabit small bodies of water, such as temporary ponds, and they might appear rare due to undersampling of these ephemeral habitats. The other species, however, are inhabitants of permanent bodies of water, and their scarcity is probably real.

MATERIALS AND METHODS

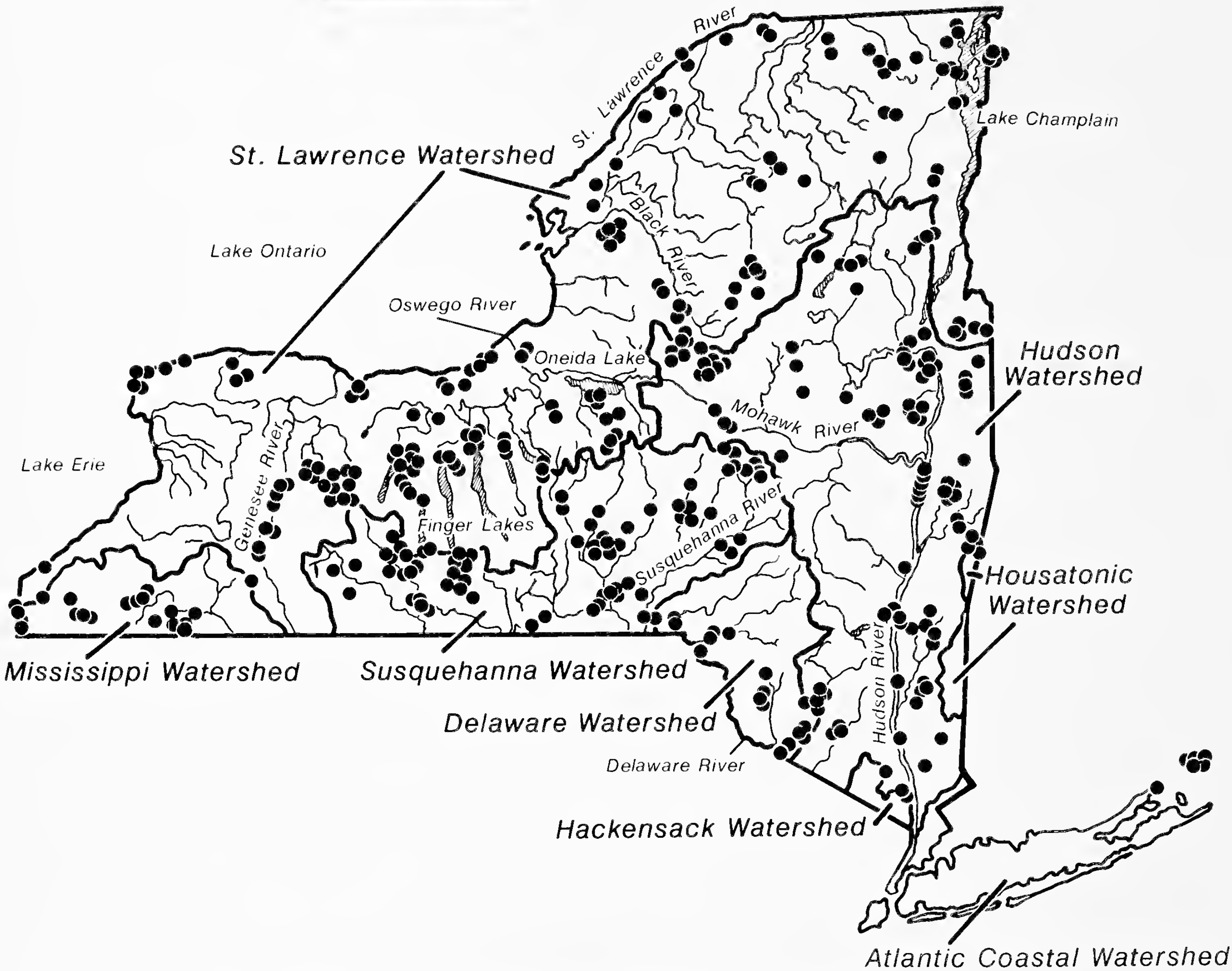


Fig. 1. Watersheds of New York State and collecting sites visited during the present survey.

Methods for finding snails included visual examination of vegetation, detritus, and bottom material; sweep netting aquatic vegetation; and digging for sediment-dwelling species. Usually, several sites per habitat were investigated. The snails were anaesthetized overnight in sodium nembutol (van der Schalie 1953) and preserved in 70% ethanol. Identifications are based on Clarke (1973), Baker (1928a), Berry (1943), Clench & Fuller (1965), Te (1975, 1978), Burch (1982), Harman & Berg (1971), Taylor & Jokinen (1984), and Jokinen (1983).

The following data are available on an electronic database from the New York State Museum for each specimen lot: catalog number, preservation method, species name, collection date and locality, major drainage basin (system draining into the Atlantic Ocean, e.g., Hudson River, St. Lawrence River, etc.), subdrainage system (system draining directly into the major drainage basin, e.g., the Mohawk River for the Hudson River system), water body type (lake, stream, marsh, canal, ditch, etc.), lake or pond surface area, altitude, water chemistry parameters (pH, conductivity, cations), number of specimens in lot, collector's remarks, and, for cross-reference, the collector's site number. Interested researchers can access information under any of the above categories for

any species. For example, a species list with accession numbers can be generated for snails of Oneida Lake, snails for Orange County, and so on.

Water samples were taken at each site and chemical analyses were made by the following methods at a standard laboratory temperature of 25°C:

- pH: Corning Model 10 pH meter and combination electrode;
- Conductivity (μmhos/cm): YSI Model 31 Conductivity Bridge, cell constant = 0.1;
- Cations (Ca^{++}, Mg^{++}, Na^{+} and K^{+} in parts per million): by atomic absorption and emission with a Perkin Elmer Atomic Absorption Spectrophotometer Model 306. Direct measurements of divalent cation concentrations, especially for calcium, replace standard alkalinity data; they are more reliable at all pH values and are independent of temperature.

Appendix B is an alphabetical list of the collecting sites giving their water chemistry parameters. Parameter ranges, means, and standard errors of the mean are given with the discussions of the species.

Aquatic snails live in nearly all standing or flowing waters, including temporary pools, ditches, watering troughs, ponds and lakes, intermittent and permanent streams, rivers, and marshes. They are commonly found near shore on submerged terrestrial litter, such as branches and leaves. Other habitats include cobble and boulders, clam shells, undersides and stems of aquatic macrophytic vegetation, filamentous green and blue-green algae, old bottles and cans, sand (where they can be completely buried), and out of water on mud, leaf litter, or rocks near water's edge. Often, they can be easily collected by hand. Netting the substratum also is effective, and a quick way to find snails is to net live vegetation, litter, or other material and shake it over white pans or into the net while holding it under water. Most individuals will drop to the bottom, where they are easily seen. Deep water collecting can be done with an Eckman dredge or with the aid of SCUBA or snorkeling equipment.

If snails are to be brought back alive from the field, they should be carried in a small amount of water with a good air space between the water and the jar lid. When they are enclosed without an air space they soon deplete the dissolved oxygen and die. In warm weather, keeping the snails in a picnic or camp cooler while traveling is recommended.

Accurate identification of some species relies on the anatomy of soft tissues, so it is necessary to preserve the soft tissues as well as the shell. If snails are dropped directly into preservative they withdraw into their shells, and dissection or examination of soft tissues is difficult. Therefore, they should be narcotized, or relaxed, before preservation. Relaxants include sodium nembutol (van der Schalie 1953), pentobarbital (Meier-Brook 1976a, 1976b), propylene phenoxytol (McKay & Hartzband 1970), and menthol crystals. Usually, leaving pulmonate and small prosobranch snails in relaxant overnight is sufficient for relaxation. Menthol crystals, which are often available at a pharmacy, are useful for relaxing many species. They should be sprinkled into the container with the snails. If nothing else is available, tobacco from menthol cigarettes also will act as a narcotizing agent when sprinkled on top of the water. The snails are relaxed when they are lying inactive and their bodies are not withdrawn into the shells. They should not react when gently prodded.

Snails can be placed in preservative once they are relaxed. The preservative of choice is 70% ethyl alcohol. It is recommended that the alcohol solution include 5% glycerine to prevent the snails from drying out if the alcohol should evaporate. Fifty percent isopropyl alcohol (rubbing alcohol) can be used until a more appropriate preservative can be substituted.

Snail tissues to be used for histological examination require special fixatives following narcotization. A common tissue fixative for snails is FAA (10 parts saturated formalin solution (39-40% formaldehyde), 2 parts glacial acetic acid, 50 parts 95% ethyl alcohol, 40 parts water). Appropriate histological references should be consulted (e.g., Humason 1972).

Specimens must be properly labeled with collection data. Labels and field notes should be recorded immediately after making a collection. Containers can be labeled with a waterproof marker until the snails are preserved. Also, waterproof paper labels can be attached to the outside. Paper labels should not be placed inside a container with live snails. Penciled labels can still be read if they get wet.

Permanent paper labels placed in the jars with the preserved snails are written on 100% rag paper with waterproof India ink. The ink is allowed to dry for several hours before placing the label in the preservative.

Data taken at the time of collection include the name of the body of water, collecting date, and locality. Other helpful data include type of microhabitat (specific location within the habitat), associated vegetation (both terrestrial and aquatic), latitude and longitude, and water depth. Any habitat or ecological data could be useful. Of special value in relocating sites is the name of the pertinent United States Geological Survey topographic map.

Many snails can be identified to species by shell characteristics alone. Others, including hydrobiids and physids, can be identified only to genus or family by shell characteristics, and inspection of soft tissues is necessary for species identification. Details are presented in the appropriate keys.

Some shell features, such as spiral striae and hirsuteness, are best viewed on a dry shell, with the body removed. Shell details (color, texture, ornamentation) mentioned in most shell keys or manuals are described from clean, dry shells free of soft tissues. Shells can be cleaned with a small brush under gently running water. Soap or a mild base can be used (e.g., a weak solution of Clorox®). The shell will dissolve if it is placed in acid. Shells should be housed in stiff boxes or glass shell vials with light cotton packing to protect them from breakage.

HISTORY OF FRESHWATER MALACOLOGY IN NEW YORK STATE

The study of snails and clams in New York State was initiated in 1843 with the publication of James E. De Kay's *Mollusca*. De Kay (1792-1851) was trained as a physician, but his primary interest was paleontology. He worked on the early New York State Geological and Natural History Survey (1836-1844) and authored the "Zoology of New York," six parts in five volumes, one of which was the *Mollusca* (Johnson 1904, Elliot 1979). In his introduction, De Kay credited Augustus A. Gould's *Invertebrata of Massachusetts* (1841) as the basis for identification of the New York fauna (De Kay 1843). Gould's type collection, purchased by the New York State Museum in 1867, is now housed at Harvard University (Anonymous 1875a, Johnson 1984).

De Kay's publication appeared during an era when exhibition of natural objects in public and private museums was gaining popularity. Shell collecting was a popular avocation of educated citizens, along with the consequent cataloguing, trading, and writing of articles for such scientific periodicals as the *American Journal of Conchology* and the *Proceedings of the Academy of Natural Sciences*. One of the most active collectors and writers during the 1850s and 1860s was Dr. James Lewis, a physician from Mohawk, New York. Lewis collected extensively from the Erie Canal and throughout the region of Mohawk, in Herkimer and Otsego Counties. He had an intense interest in evolution and urged colleagues to pay attention to intraspecific variability of shell characters in relation to environment. Lewis affirmed Darwin's theories, urged conservative taxonomy as opposed to naming each variant population as a separate species, and he proposed that pulmonates were of later evolutionary origin than prosobranchs. He experimented with transplantation of populations by placing *Viviparus georgianus* from Illinois in the Erie Canal in 1867. He also introduced several species of the clam *Unio* from Ohio (Lewis 1856b, 1860, 1868, 1872, 1874). Lewis's collection of molluscs was deposited in the New York State Museum in 1875 (Anonymous 1882).

In 1866 and 1867, Truman Aldrich, of Rensselaer Polytechnic Institute, collected aquatic and terrestrial molluscs in the Hudson River, Mohawk basin, and the Erie Canal within a six mile radius of Troy (Aldrich 1869). His collection was presented to the New York State Museum (Anonymous 1875b).

Staten Island and Long Island were sampled by Sanderson Smith (1832-1915), curator of shells at the American Museum of Natural History, and Temple Prime (1832-1903), a lifelong resident of Huntington, Long Island (Hubbard & Smith 1865, Smith & Prime 1870). Although Prime did not publish much on snails, he was an expert on corbiculid clams and named numerous species (Johnson 1959, Abbott & Young 1973, Elliott 1979). In 1872, Prime donated specimens of 106 species to the New York State Museum and a similar set to the Long Island Historical Society (Anonymous 1873). His main collection was deposited in the Museum of Comparative Zoology at Harvard University in 1895 (Elliott 1979). Later publications on Long Island, Staten Island, and Brooklyn molluscs were authored by S.C. Wheat (1907a, b), a resident of Brooklyn and a member of the Brooklyn Conchological Club.

In the 1880s, collections in Onondaga County and other parts of New York were being made by the Reverend William Beauchamp (1830-1925), Episcopal priest, published amateur conchologist, and expert on the language, history, and culture of the Iroquois (Smith 1926, Abbott & Young 1973). Beauchamp (1886a, 1887, 1891) published articles in *The Nautilus* (the first few volumes were named the *Conchologists' Exchange*). As a result of ten years' work, Beauchamp (1886b) privately published a booklet on terrestrial and aquatic shells of New York State, primarily those of Onondaga County. That publication is not merely a list of species; it includes instructions on where and how to collect specimens and preserve them.

A major contributor of freshwater and terrestrial specimens to the New York State Museum was Charles Beecher (1856-1904), who was also an expert on trilobites and brachiopods. While serving as a paleontological assistant to James Hall at the State Museum, Beecher contributed approximately 20,000 primary specimens, plus a similar number of duplicates. The shells came from Albany, New York; Ann Arbor, Michigan (where Beecher received his Bachelor of Science degree); and Warren, Pennsylvania. All were collected by Beecher himself. In 1899, Beecher was appointed curator of geological collections at the Peabody Museum, Yale University. It was to the Peabody that Beecher donated a second collection of over 100,000 specimens (Schuchert 1904, Abbott & Young 1973, Elliott 1979).

In the 1890s, William Marshall (1865-ca. 1958), as assistant zoologist of the New York State Museum, catalogued and reported on the freshwater and terrestrial molluscs deposited in the museum and exhibited at the 1893 World's Columbian Exposition in Chicago. By this time, collections from C.E. Beecher, W.M. Beauchamp, W.S. Teator, A. Baily, and others had been acquired by the Museum (Marshall 1894, 1895). Marshall (1892) also followed up on Lewis' successful transplantation of *Viviparus georgianus*

into the Erie Canal and Mohawk River. Also during that period, Mearns (1898) reported on terrestrial and aquatic molluscs of the Hudson Highlands in Ulster, Orange, and Greene Counties, and William S. Teator (1860-1930), a farmer and naturalist, was collecting molluscs from near his home in the Hudson Valley at Upper Red Hook, Dutchess County (Garlinghouse 1976). Recently, a part of the Teator collection was donated to the American Museum of Natural History.

Molluscan studies in eastern New York State were concentrated around New York City, Albany, Rensselaer, and Herkimer Counties, but explorations were also occurring in western parts of the State. John Walton published an extensive and well-illustrated list of freshwater and terrestrial molluscs from Monroe County (Walton 1891, 1898).

The first instructional handbook for shell collectors was published in 1898 by paleoecologist Carlotta J. Maury (1874-1938). The three-chapter handbook was based on Chautauqua Lake shells. Included were sections on collecting, aquarium-keeping, molluscan habits, in-lake distribution, and the history of post-glacial clam migration from the Mississippi Valley. Paleontological works include Maury (1908). Maury (1916) later published a list of the shells from Cayuga, Cayuta, Chautauqua, Canandaigua, Conesus, and Owasco Lakes that she had given to Cornell University. Baker (1928b) later compared data from Maury's Chautauqua Lake collection with his own observations.

The western part of the State was also explored for freshwater molluscs by Elizabeth J. Letson Bryan (1874-1919), a member and a director of the Buffalo Society of Natural Sciences. Letson published on shells from the Niagara Frontier, including post-Pliocene fossils of the Niagara River gravels (Letson 1901, 1909). She also published a "Check List of the Mollusca of New York" (Letson 1905) and several articles in *The Nautilus*. After marrying William Bryan of the College of Hawaii, she moved to Hawaii, where she and her husband amassed the largest collection of Hawaiian marine shells of the time (Pilsbry 1919). Part of her collection of New York specimens is housed in the New York State Museum (Letson 1905).

One of the most prolific contributors to New York's early 20th century malacology was Frank Collins Baker (1894-1942), best known for his publications on Wisconsin freshwater molluscs (Baker 1928a). As a young man, Baker worked for Ward's Scientific Establishment in Rochester before he was appointed curator at the Chicago Academy of Science in 1894. Baker returned to New York for the years 1915-1917, when he carried on research at Oneida Lake for the New York College of Forestry (Baker 1916a, b; 1918a, b, c; 1919a; van Cleave 1943; Abbott & Young 1973). Baker's work on Oneida Lake's benthic community was quantitative, qualitative, and highly detailed, and it was an impressive forerunner to the ecological studies of later researchers. Between 1899 and 1928, Baker wrote numerous papers on New York's and New Jersey's extant and Pleistocene freshwater molluscs. Many of these publications were the result of explorations made during his summer vacations near Rochester (Baker 1898, 1900b, 1901, 1913). Later publications on Oneida Lake's molluscs include those of Henry Pratt (1923) and Harman & Forney (1970).

From the 1940s to the 1970s, Morris K. Jacobson (1906-1980), a high school foreign languages instructor, was an active amateur malacologist. He founded the New York Shell Club in 1949, and he authored nine books and over 65 papers on molluscs and other invertebrates. Several of his publications deal with molluscs of the vicinity of New York City (e.g., Jacobson 1945, 1951, 1965, 1969), and in 1961, under joint authorship with William Emerson of the American Museum of Natural History (Jacobson & Emerson 1961), the book *Shells of the New York City Area* appeared (Abbott 1980). Additional studies of snails in the vicinity of New York City were published by Dorothy Freas (1950a, b; 1951), and by Roger Bretet and Edwin Carswell (Bretet & Carswell 1952).

One of the major contributors to current New York malacology, especially in central New York, is Willard Harman, who began publishing as a graduate student of Clifford Berg's at Cornell University. Berg's main interest in molluscs was the fact that they are the food source of the larvae of the predatory and parasitoid snail-killing flies (Diptera: Sciomyzidae) (Berg & Knutson 1978). Harman's studies include gastropod surveys of central New York (Harman & Berg 1970, 1971; Harman 1982), Green Lake (Harman & Jackson 1967), Otsego Lake (Harman 1971, MacNamara & Harman 1975), Canadarago Lake (Harman 1973), and Oneida Lake (Harman & Forney 1970). In addition to survey work, Harman has published on various aspects of gastropod natural history and ecology (e.g., Lanciani & Harman 1968; Harman 1968a, b; 1970, 1972).

Recently, Douglas Smith (1983) and David Strayer (1987) have published on the molluscan fauna of the Hudson River basin. Jean Q. Wade and Carey E. Vasey are conducting studies on molluscs of Livingston County, especially the community in Conesus Lake (e.g., Wade 1980, 1987; Wade & Vasey 1976).

HYDROLOGY, CLIMATE, AND GEOLOGY OF NEW YORK STATE

The State of New York encompasses an area of 127,190 square kilometers, approximately 10% (13,876 square kilometers) of which is water surface. There are over 4000 lakes and ponds with more than 260 square kilometers of surface area, and there are 130,000 kilometers of rivers and streams. The climate is humid, cloudy, and cool. The Great Lakes, especially Lakes Erie and Ontario, influence temperature and snowfall. Annual precipitation ranges from 76 cm in western New York to 127 cm north of New York City and in the Adirondack Mountains. Information in this section is based on Berg (1963), Broughton *et al.* (1966), Van Diver (1985), and van der Leeden *et al.* (1990).

New York is drained by several primary watersheds (Fig. 1). The St. Lawrence River watershed, originating with the Great Lakes, drains water from the northern part of the State into the Atlantic Ocean at the Bay of St. Lawrence. The Hudson River watershed drains water from approximately 34,000 square kilometers of the eastern and central regions into the Atlantic Ocean at New York City Harbor. The Delaware River watershed directs water south

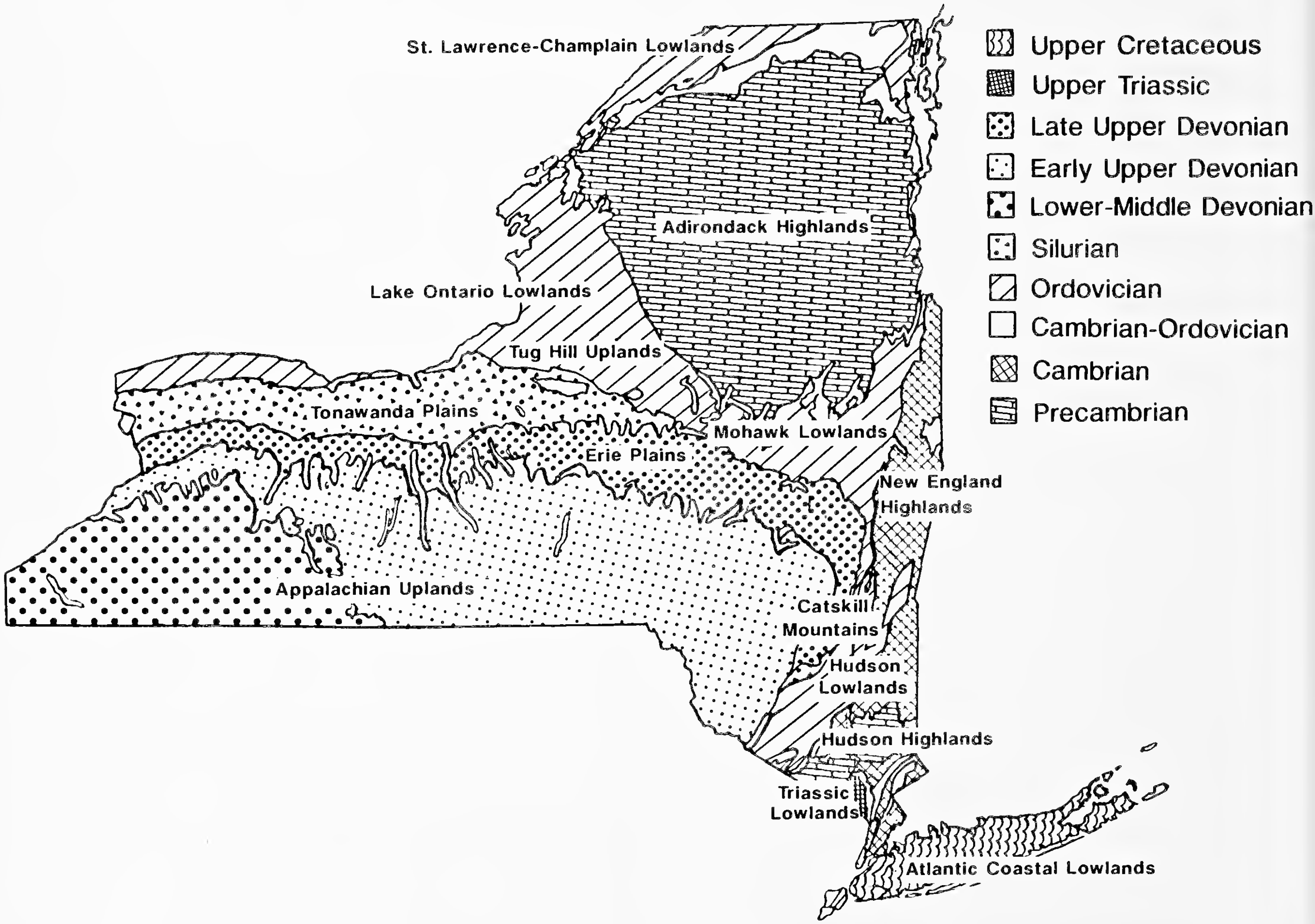


Fig. 2. Geological regions of New York State. Symbols represent exposed bedrock formations. Precambrian formations tend to be low in calcium-bearing rock, thereby yielding soft waters with low pH.

from the southeastern region of the State, west of the Hudson River, into the Atlantic Ocean at Delaware Bay. The Susquehanna River watershed, in south-central New York, directs water into the Atlantic Ocean at Chesapeake Bay. The Mississippi River watershed, represented in southwestern New York by the Allegheny River, flows into the Gulf of Mexico. The northern section of the Housatonic River, draining water from western Connecticut, southwestern Massachusetts, and a small section of southeastern New York, flows into Long Island Sound. The Hackensack River, draining a small section west of the Hudson, empties into Newark Bay and the Hudson River Estuary. The Atlantic Coastal Plain rivers are small drainage systems from eastern Fishers Island in Long Island Sound south to New Jersey.

The Adirondack Highlands (Fig. 2) are a southeasterly extension of the Grenville Province of the Precambrian Canadian Shield. The High Peaks, up to 1524 m above sea level (average relief: 610 m), have the greatest elevations in the State. East of the High Peaks, elevations drop abruptly to 29 m at Lake Champlain. Most of the rocks of the Adirondacks are metamorphic and poor in calcium: amphibolite, anorthosite, granitic gneisses, and small amounts of metasedimentary rock (marble, calci-silicates, quartzite, and paragneisses). Water from the region is drained to the west, east, and north by St. Lawrence River tributaries and to the south by the Mohawk and upper Hudson River systems. Most lakes were glacially produced, are low in calcium (less than 5 ppm), and are naturally oligotrophic. The poor buffering capacities of Adirondack waters have made them especially susceptible to the effects of acid rain and intolerable to the majority of freshwater molluscs (Jokinen 1991).

The St. Lawrence-Champlain Lowlands, including the St. Lawrence River Valley and Lake Champlain, lie north and east of the Adirondacks. The average elevation is 31 m, and water drains into the St. Lawrence River system. The underlying rocks are Cambrian and Ordovician sandstones, dolomites, and limestones. Because of the limestone, the waters of this region have higher calcium levels, lower acidity, and greater buffering capacities than those of the Adirondacks.

The Lake Ontario Lowlands border Lake Ontario and extend up the Black River Valley. Elevations range from 74 m at the lake to 457 m inland in the eastern portion. Surficial deposits consist of calcareous silts and clays derived from Ordovician limestone and dolomite. In the eastern section of the Lowlands are the Tug Hill Uplands, consisting of sedimentary sandstone. The elevation is 549-610 m, and relief is low. Below the sandstone is a series of sandy shales underlain by limestone, which forms a series of rock terraces along the west side of the Black River Valley. Poor drainage has resulted in the presence of many swamps, and the limestone has produced waters high in calcium.

The northwestern portion of the Lake Ontario Lowlands has hard water ponds and rivers (greater than 20 ppm calcium). The southern border of the western Lake Ontario Lowland is the 76 m high Niagara Escarpment, which forms the northern edge of the Tonawanda Plain of Silurian dolostone, limestone, shale, salt beds, sandstone, and conglomerate. The surficial landscape includes one of the largest drumlin fields in the world. The waters of the Plain are high in calcium.

The greater part of the southern half of New York is made up of the Appalachian Uplands, which consist of three sections of Devonian sedimentary rocks now dipping to the south. The Uplands consist of shale, siltstone, and sandstone mixed with limestone. The Finger Lakes are located in the center of this section. The eastern end contains the Catskill Mountains, which end abruptly at an escarpment rising 610 m above the Hudson River. Catskill waters drain into the Delaware River.

Some waterways, such as the Genesee River and its tributaries, drain west to north to the St. Lawrence system, but the dominant watersheds are the Susquehanna and Delaware. The Susquehanna and Oswego Rivers drain a number of glacially formed swamps and marshes in common, and some snail migration might have been via this connection (Harman & Berg 1971). The waters have low to high calcium values, and river systems dominate over lakes south of the Finger Lakes.

In the southwest section, the only large standing body of water is Lake Chautauqua, Chautauqua County. Most of the waters are of high calcium, and drainage is primarily via the Allegheny River system south to the Ohio River and eventually to the Mississippi. The western section, adjacent to Lake Erie, drains into the St. Lawrence River system.

A small triangle, an extension of the Allegheny Plateau, occupies a region bordering on Pennsylvania and is the only section of New York that remained unglaciated. The waters here are very low in calcium.

The Hudson-Mohawk Lowlands, drained by the Hudson and Mohawk Rivers, lie south of the Adirondacks and extend south to Pennsylvania. The Mohawk Lowlands are bordered on the south by the Helderberg Escarpment, and the surficial deposits consist of glacial till derived from limestone and alkaline shales of Silurian origin. The Hudson Lowlands lie between the Catskill Mountains on the west and the Taconic Mountains, part of the New England Highlands, on the east and consist of Cambrian-Ordovician slate, shale, schist, gneiss, limestone, dolomite, quartzite, marble, and graywacke. Calcium values are high.

East of the Hudson Lowlands are the New England Highlands, a geologically complex province consisting of the Hudson Highlands, New York City Group, and the Taconic Mountains. The highest relief is in the Hudson Highlands where the elevations exceed 457 m. The majority of the ridges and valleys of the highlands follow a northeast to southwest direction and consist of Precambrian metamorphic gneisses and quartzites. Waters of this region are very low in calcium.

The Taconic Mountains lie in a north-south direction and consist of schist uplands, limestone valleys, and the Rensselaer Plateau formed by Rensselaer Graywacke. The calcium content of the waters is relatively high.

At the southwestern edge of the Hudson Lowlands is the Triassic Lowland, lying within the borders of Rockland County. The bedrock consists of conglomerates, red sandstones, red shales, and diabase. The most obvious feature of the Triassic Lowland is the Palisades, a north-south escarpment on the west bank of the Hudson River extending from Nyack to Staten Island.

The Atlantic Coastal Lowlands, of Cretaceous sedimentary rocks overlain by glacial drift, make up Staten Island and Long Island. Drift consists of unconsolidated gravels, sands, and clays. Elevations and relief are low, as are soil nutrients and lime.

Almost all of New York State was heavily glaciated during the Wisconsinan Glaciation. The shapes, sizes, and flow direction of the water bodies were all profoundly influenced by the ice sheet. Berg (1963) summarized the major basin-forming processes as uplift and tilting by rebound following deglaciation, excavation of plunge pools, and formation of kettle lakes. The Finger Lakes were formed from gouged river valleys, and Seneca and Cayuga have lake bottoms below sea level. Waterfalls, such as those at Taughannock and Watkins Glens, originated from valleys of tributary streams left hanging high above newly scoured valley floors. Long Island and associated islands in Long Island Sound consist of end moraines dropped by the glacier as it began to recede.

The primary geological factor of importance in the distribution of snail species is bedrock chemistry. Snails differ in their abilities to extract calcium from their environment. Some species (e.g., *Stagnicola elodes)* appear to require relatively high levels of dissolved calcium (greater than 6 ppm) to maintain populations. Other species (e.g., *Amnicola limosa* and *Micromenetus dilatatus)* are tolerant of low dissolved calcium (less than 5 ppm) and maintain viable populations in soft, acidic water. Areas where the bedrock is of acidic, low calcium material have lower species diversity than do areas where the rock is limy. Within New York State, the Adirondack Mountains contain a large number of aquatic habitats of very low calcium content and therefore, have fewer species and lower diversity communities in lakes and streams (Jokinen 1991).

Another important aspect of geology in regard to snail distribution is topography, with its resultant drainage types. For example, areas of moderate drainage will have intermittent ponds and streams in early spring, but these dry up during late summer. Animals existing in these ephemeral habitats need survival mechanisms to tolerate dry periods. Most snails need permanent water, but species such as *S. elodes*, *Gyraulus parvus*, *G. circumstriatus*, and *Aplexa elongata* are able to aestivate over drought and maintain populations in habitats otherwise inaccessible to most aquatic gastropods.

In areas of high relief rivers can predominate over lakes as aquatic habitats. Species of Pleuroceridae and the ancylid *Ferrissia rivularis* might be the only gastropods found in rapids areas. In fact, *F. rivularis* appears to require the high oxygen levels found in swift waters and is not common in still waters. The river pools and backwaters have communities similar to those found in lakes.

Glaciated areas tend to have numerous lakes formed from kettles and drift-dammed streams. Consequently, molluscan diversity can be higher than in areas where lakes and ponds are rare. Areas of poor drainage can contain swamps and marshes, which act as connections between drainages and conduits for snail migration. Geological effects on the distribution of aquatic molluscs are complex and involve an array of chemical and physical factors.

CANAL SYSTEM OF NEW YORK STATE

The 19th century in New York State was an era of building canals for the transportation of goods to many American and Canadian ports. The major canal was the Erie, which was completed in 1825. It connected Albany on the east with Buffalo on the west. A number of additional canals, called laterals, were built to connect the Erie with regions north and south. The canal system connected a number of major watersheds and allowed the migration of aquatic snail species from one to the other.

Many sections of the canals were located in major river valleys. Drainage originated at the summit of the canal and flowed in two directions toward and down the connected valleys. A number of streams were captured and lakes dammed as reservoirs to act as feeders supplying the canals with enough water to maintain proper depth during low-flow periods. Even after the lateral canals were abandoned, a number of feeders were maintained as water sources for the Erie (Whitford 1906). Because of canal, feed-

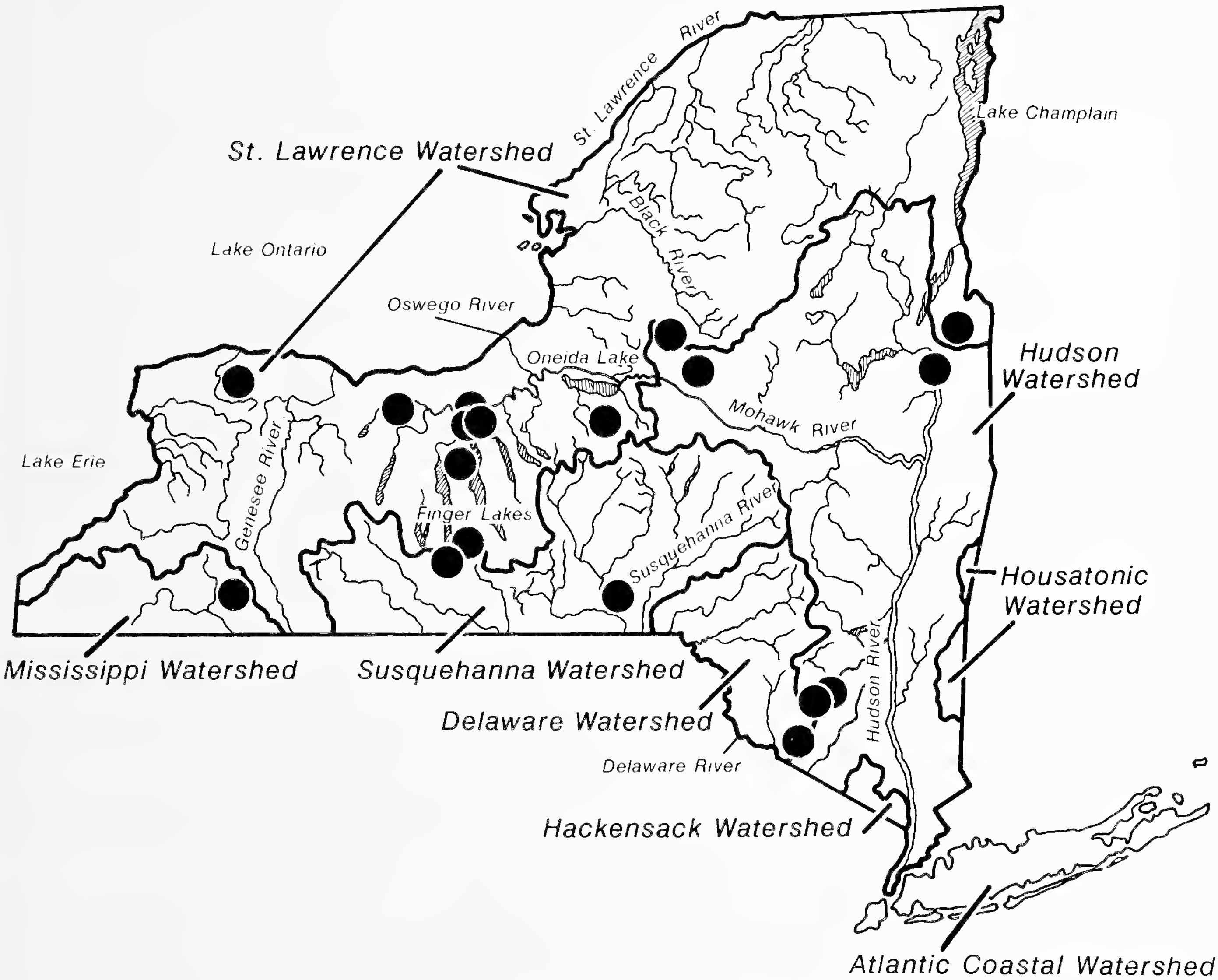


Fig. 3. Canal sites visited during the present survey.

er, and reservoir construction, abandonment and filling of many canal sections, but not others, and natural flood events of the rivers, the drainage history of New York State along canal routes is complex and confusing, but it undoubtedly had effects on freshwater snail distributions. Because of the importance of the canals, the following history is provided. Comments on snail presence (see Fig. 3) and abundance in portions of these canals are included.

The Champlain Canal, connecting the Hudson River at Waterford with Lake Champlain near Whitehall, Washington County, was completed in 1823. This 66-mile-long canal carried lumber from the Lake George-Lake Champlain region to New York City. The Canal followed the bed of Wood Creek into Lake Champlain for several miles. In 1837, a 12-mile-long feeder from Glens Falls to the canal was completed. Improvement authorized in 1900 made the Champlain Canal part of the Barge Canal project, and the Canal is still operative (Whitford 1906, Papp 1977).

During or just prior to 1878, *Bithynia tentaculata* was found in two places in New York State, Lake Ontario at Oswego, Oswego County, and the Champlain Canal at West Troy, Rensselaer County (Beauchamp 1886b, Marshall 1894). The present survey included two sites in the Champlain Canal system, the Canal itself at Fort Ann (site number 312) and the Glens Falls feeder at Glens Falls (299). Small populations of three species (*Amnicola limosa, Physa heterostropha,* and *Helisoma trivolvis*) were found.

The Erie Canal, extending 363 miles from Albany to Buffalo, was completed in 1825. Water flow was from Niagara toward Rome toward Oneida Lake, and Rome east toward Albany and the Hudson River. The history of the Erie Canal, its improvements, and the construction of the parallel Barge Canal, begun in 1905, is complex, and sources such as Whitford (1906), Finch (1925), Payne (1959), and Papp (1977) can be consulted for details.

Due to the experiments of Dr. James Lewis in Mohawk, Herkimer County, the establishment of molluscs in the Erie Canal is better documented than for any other New York canal. By 1860 a molluscan community had become well-established in the Canal in the vicinity of Mohawk. In addition to several clam species, the following snail species had populations in the Canal: *Campeloma decisum*, plentiful; *Goniobasis virginica*, local, recently introduced; *Amnicola limosa*, plentiful; *A. walkeri* (?, as *A. lustrica*), plentiful; *Valvata tricarinata; Stagnicola elodes*; and *S. catascopium*, abundant (Lewis 1860). A decade later, Lewis (1872) noted additional species, including *Cincinnatia cincinnatiensis; Fontigens nickliniana* (as *Bythinella obtusa*); *Goniobasis livescens*, introduced from western waters; *Helisoma anceps; H. trivolvis; Birgella subglobosa*, introduced from the west since 1860 and numerically more abundant than any other mollusc in the canal; and *Viviparus georgianus*, a colony from Illinois planted in the canal in the fall of 1867, now thriving. By 1892, *V. georgianus* had migrated east to Amsterdam, Montgomery County (Strayer 1987) and Albany, Albany County (Marshall 1894).

Four sites were sampled on the Erie Canal system during the present survey: Ridgeway Township, Orleans County (443), which yielded the species *Physa gyrina* and *Helisoma trivolvis*; Widewaters at Arcadia Township, Wayne County (504), which yielded *Physa integra (?)* and *Goniobasis livescens*; the Old Erie Canal at Sullivan Township, Madison County (565), which yielded *Fossaria rustica* and *Physa heterostropha*; and the feeder canal from West Canada Creek, Trenton Township, Oneida County (380), which yielded the river ancylid, *Ferrissia rivularis*.

The Cayuga and Seneca Canal, completed in 1821, connected Cayuga and Seneca Lakes for shipment of flour, salt, gypsum, and grain. In 1828, the 20-mile canal connected the Erie Canal at Montezuma with Seneca Lake, at or near Geneva (Whitford 1906).

Four sites along the Cayuga and Seneca Canal system were sampled during this survey: Waterloo Township, Seneca County (527); Mud Lock, Aurelius Township, Cayuga County (531); Tyre Township, Seneca County (534); and a portion of the abandoned canal near the Mud Lock portion of the Canal, Aurelius Township, Cayuga County (532). The diversity and abundance of snails collected in the active Canal (527, 531, 534) were fairly high. Species found included *Amnicola limosa, Bithynia tentaculata, Goniobasis livescens, G. virginica, Pleurocera acuta, Physa gyrina, P. integra, Helisoma trivolvis, Gyraulus parvus, Laevapex fuscus, Ferrissia rivularis*, and *F. parallela*. In marl deposits at Aurelius, shells of *Helisoma campanulatum, Helisoma anceps, Stagnicola elodes*, and *S. catascopium* were found. The marl at Tyre included shells of *Pomatiopsis lapidaria, H. anceps, S. catascopium*, and *G. parvus*. The marls contained different species from those found alive, indicating a change in community structure over the last century. The modern absence of lynmaeids is notable. The portion of the abandoned canal at Mud Lock was filled with the macroalga *Chara* sp. *Stagnicola elodes* and *Physa gyrina* were abundant in a flowing portion containing sulfur bacteria.

The story of the Delaware and Hudson Canal is linked with the development of a market for coal. The Canal, opened in 1827, ran for 59 miles from Kingston, on the Hudson River, to Port Jervis, on the Delaware. It continued 22 miles up the Delaware, and 25 miles up the Lackawaxen River to the Honesdale terminus. In 1899 the entire bed of the Canal was sold to private parties, and later it was sold to the railroads (Whitford 1906).

Lewis (in Marshall 1894) theorized that *Lioplax subcarinata* entered the lower Hudson via the Delaware and Hudson Canal, but evidence does not exist to substantiate that claim.

During this survey, four sites on the Delaware and Hudson Canal were sampled: Deerplace Township, Orange County (455); Mamakating Township, Sullivan County (460, 463), and Summitville Township, Sullivan County (462). Sampling yielded a moderately high diversity of pulmonates in moderate densities, but no prosobranchs. Species included *Fossaria modicella, Stagnicola emarginata, Pseudosuccinea*

columella, Physa ancillaria, P. gyrina, P. heterostropha, Helisoma trivolvis, Gyraulus parvus, G. deflectus, Micromenetus dilatatus, and *Planorbula armigera*.

The Chemung Canal, completed in 1831, was 39 miles long and designed to connect the New York State waterways from Elmira, Tioga County, with the Chemung River, a branch of the Susquehanna River, and from there to the bituminous coal fields of western Pennsylvania. The two important feeder sources were the Chemung River and Catharine Creek. By the 1870s, the Fall Brook Railroad, which ran nearly parallel with the canal and extended into the coal fields, outcompeted the canal and caused its closure in 1878. A portion at Montour Falls was reopened later as a waterway through Seneca Lake and the Seneca and Cayuga Canal (Whitford 1906). The Canal's effect on molluscan migration has not been established (Clarke & Berg 1959).

During this survey, two sites from the Chemung system were sampled: the diversion channel from Catharine Creek to the Barge Canal (394), and the Barge Canal (395) (Catharine Creek) to Seneca Lake, Montour Falls, Schuyler County. Although snail diversity was low (three species), the population levels of two species were high in the diversion channel. Large numbers of *Stagnicola elodes* and *Physa heterostropha* and a small number of *Helisoma anceps* were found. Only *P. heterostropha* was found in the Barge Canal.

In 1836 the Chenango Canal was completed. It extended for 97 miles from Binghamton, Broome County, up the valley of the Chenango River, a tributary of the Susquehanna, to its headwaters, and then north to the Erie Canal at Utica. An extension was built from Binghamton, along the valley of the Susquehanna, to the State border near Tioga Point. By 1877, competition from the railroads prompted the Canal's abandonment, except for the reservoirs that flowed north and could supply water to the Erie Canal at Oriskany and Utica (Whitford 1906).

Only one site along the Chenango Canal was sampled. It is in Fenton Township, Broome County (554). Three species of low to moderate population density were found: *Fossaria modicella, Physa heterostropha*, and *Ferrissia rivularis*.

The 50-mile-long Black River Canal was opened to navigation in 1849. It was designed to connect the Black River of the eastern Adirondack Mountains and the lowlands of Herkimer, Oneida, Lewis, and Jefferson Counties with the Erie Canal. Several lakes, including those in the Fulton chain, were dammed as reservoirs, and water was shunted into the Lansing Kill and the Mohawk River, where it entered the Erie Canal by the feeder at Rome. Later, additional reservoirs on the Black, Beaver, and Moose Rivers were constructed to supply water to the Black River. They compensated mill owners at Watertown and Carthage for waters diverted into the Erie Canal. The Black River Canal was enduring and successful as a supplier of water for the Erie Canal (Whitford 1906).

A sampling site (367) on a remnant of the Black River Canal at Boonville yielded an extraordinary snail community of high diversity and density. Only two or three net sweeps yielded 690 individuals of *Amnicola limosa*. Other species included *Campeloma decisum, Fossaria modicella, Pseudosuccinea columella, Physa gyrina* (320 in number), *Gyraulus parvus, Helisoma trivolvis* (184 in number), and *Ferrissia walkeri*. The Canal remnant is isolated and has fairly swiftly running water. There does not appear to be a well-defined predator habitat. High oxygen, good vegetation, and low predation possibly allowed the snail populations to become extremely dense.

The Genesee Valley Canal extended 125 miles from the Erie Canal in Rochester, through the valley of the Genesee River to Mount Morris, and then to the Allegheny River at Olean. It did not open completely until 1861, although by 1840 the section between Rochester and the Genesee dam near Mount Morris was in use. A branch was built from Mount Morris up the valley of Canaseraga Creek to Dansville. By 1847 the Genesee and Erie Canals were taking so much water from the Genesee River that they impinged on water privileges of manufacturing interests in and below Rochester. Consequently, Conesus Lake in Livingston County was made into a reservoir. By 1880, roads and railways served as trade routes, and the main Canal line was abandoned and deeded to the Genesee Valley Canal Railway Company (Whitford 1906).

During this survey, a site at the summit of the Genesee Valley Canal, Cuba Township, Allegany County (415) was sampled. Diversity and abundance of snails were moderate. All species were pulmomates, including *Fossaria exigua, Physa gyrina, Helisoma anceps, H. trivolvis*, a *Gyraulus* sp., and *Ferrissia parallela*.

Species from Conesus Lake (505), a reservoir for the Canal, were abundant and included *Viviparus georgianus, Goniobasis livescens, Amnicola limosa, Pyrgulopsis lustrica, Physa integra, Gyraulus parvus*, and *Laevapex fuscus*. Shells of *Valvata tricarinata* and *V. sincera* were found in the marl, but live populations were apparently absent.

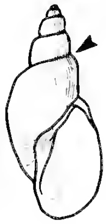
KEY TO THE FAMILIES OF FRESHWATER SNAILS

1a. Shell not coiled, shaped like a Chinese hat ....Ancylidae, limpets

1b. Shell coiled..2

2a. Shell without spire, flatly coiled 3

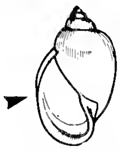
2b. Shell with spire 4



3a. Shell brown ....Planorbidae, rams-horn snails

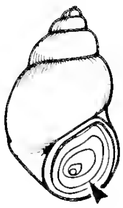
3b. Shell white to light tan...................Valvatidae, valvatids

4a. Shell sinistral; aperture on left when spire upright ....Physidae, physid snails

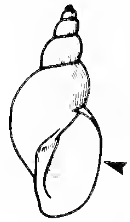


4b. Shell dextral; aperture on right when spire upright..5

5a. Shell with operculum covering aperture 6



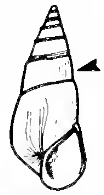
5b. Shell without operculum ....Lymnaeidae, pondsnails



6a. Shell long and tapered, at least twice as long as wide 7

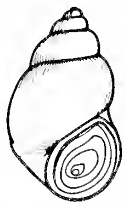
6b. Shell of various shapes, not long and tapered 8

7a. Sides of whorls flattened, sometimes with spiral ridges, adults over 15 mm high ......Pleuroceridae, elimia snails



7b. Sides of whorls rounded, shells < 15 mm high ....Pomatiopsidae, walker snails *(Pomatiopsis lapidaria)*

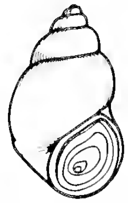
8a. Operculum concentric 9



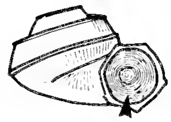
8b. Operculum spiral 10

9a. Operculum chitinous, thin; shell globose to conical......
.... Viviparidae, mystery snails

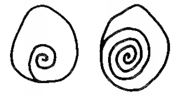
9b. Operculum calcareous, thick; shell moderately elongate ....
...........Bithyniidae, faucet snails *(Bithynia tentaculata)*



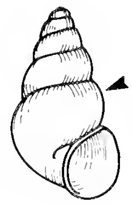
10a. Operculum multispiral throughout.................................
....Valvatidae, valvatid snails



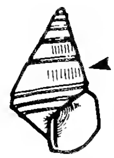
10b. Operculum paucispiral or multispiral only in center........
.... 11



11a. Whorls rounded ....
.......................Hydrobiidae, amnicolas and duskysnails



11b. Whorls flattened ....Pleuroceridae, elimia snails



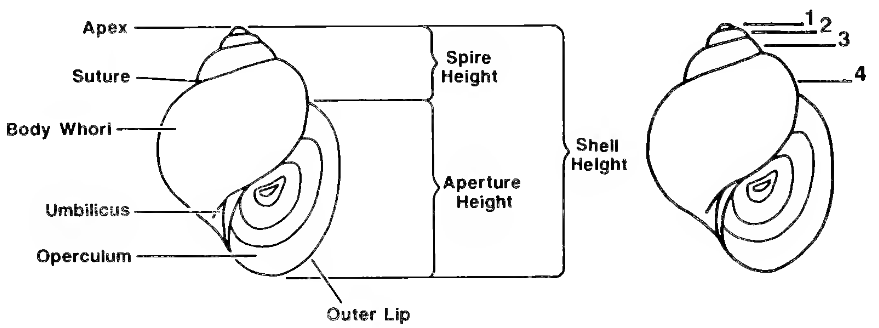


Fig. 4. Shell structure terminology. Numbers indicate whorl count (from Jokinen 1983).

DESCRIPTIONS, DISTRIBUTIONS, AND ECOLOGY OF THE SPECIES

Subclass Prosobranchia

Gill complex located anteriorly in mantle cavity; sexes usually separate (except Valvatidae); shell usually developed and provided with operculum covering shell aperture (Baker 1928a, Hyman 1967).

Order Mesogastropoda

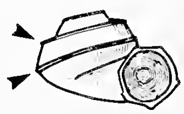
Siphon, operculum, and penis usually present; radula usually of taenioglossate type (seven teeth in each transverse row, Fig. 5a); 1 auricle, 1 gill, and 1 kidney present (Hyman 1967).

Family Valvatidae

Shell small, spiral, dextral, turbinate to subdiscoidal; whorls rounded or carinate; aperture entire, circular; lip simple, sharp; operculum circular, multispiral. Gills external; left one feather-like, extended over back; right one rudimentary, forming slender appendage (Baker 1928a). *Snails simultaneously hermaphroditic, not self-fertilizing* (Hyman 1967); *external verge long, slender, nonretractile* (Baker 1928a); *egg capsules 1-2 mm in diameter, globose, attached to substratum by capsule base; embryos inside capsule embedded in albumin covered by mucoid coat* (Fretter & Graham 1962).

Key to the Valvatidae

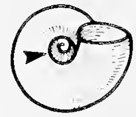
1a. Shell with 2-3 prominent spiral ridges .... *Valvata tricarinata*



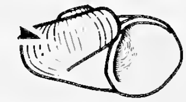
1b. Shell without spiral ridges 2

2a. Shell high-turbinate, about as high as wide; umbilicus narrow .... *Valvata piscinalis*

2b. Shell depressed to low-turbinate, wider than high; umbilicus wide 3



3a. Shell depressed, with coarse striae; spire very short .... *Valvata lewisi*



3b. Shell low-turbinate, with fine striae; spire elevated .... *Valvata sincera*

Valvata tricarinata (Say, 1817)

Threeridge valvata
Figs. 6a, 7

Shell turbinate, 6 mm wide, translucent, shiny; umbilicus deep, funnel shaped; whorls 4.0, rapidly enlarging, typically with 3 sharp carinae on body whorl: dorsally (on shoulder), peripherally, and ventrally (on base); shell flattened between carinae, sloping upward from dorsal carina to suture on upper surface; sutures distinct; lip simple, sharp, continuous, appressed to body whorl.

Some carinae can be absent in certain individuals that are considered to represent various subspecies or morphs (see Baker 1928a; Burch 1989).

This species occurs in the eastern and midwestern United States south to Virginia, west to Nebraska and Washington, and it occurs in Canada from New Brunswick to eastern British Columbia and to the Northwest Territories south of the tree line (Baker 1928a; Richards 1934; Dawley 1947; McKillop & Harrison 1972; Clarke 1973, 1981; Tudorancea *et al.* 1979; Cvancara 1983; Jokinen 1983; Smith 1987; Taylor & Bright 1987).

Populations were found in 22 collection sites in the Hudson River watershed (265, 269, 291, 453, 459, 604, 616); Ohio-Mississippi River watershed (431); St. Lawrence River watershed (141D, 338, 390, 408, 449, 493, 497, 499, 500,

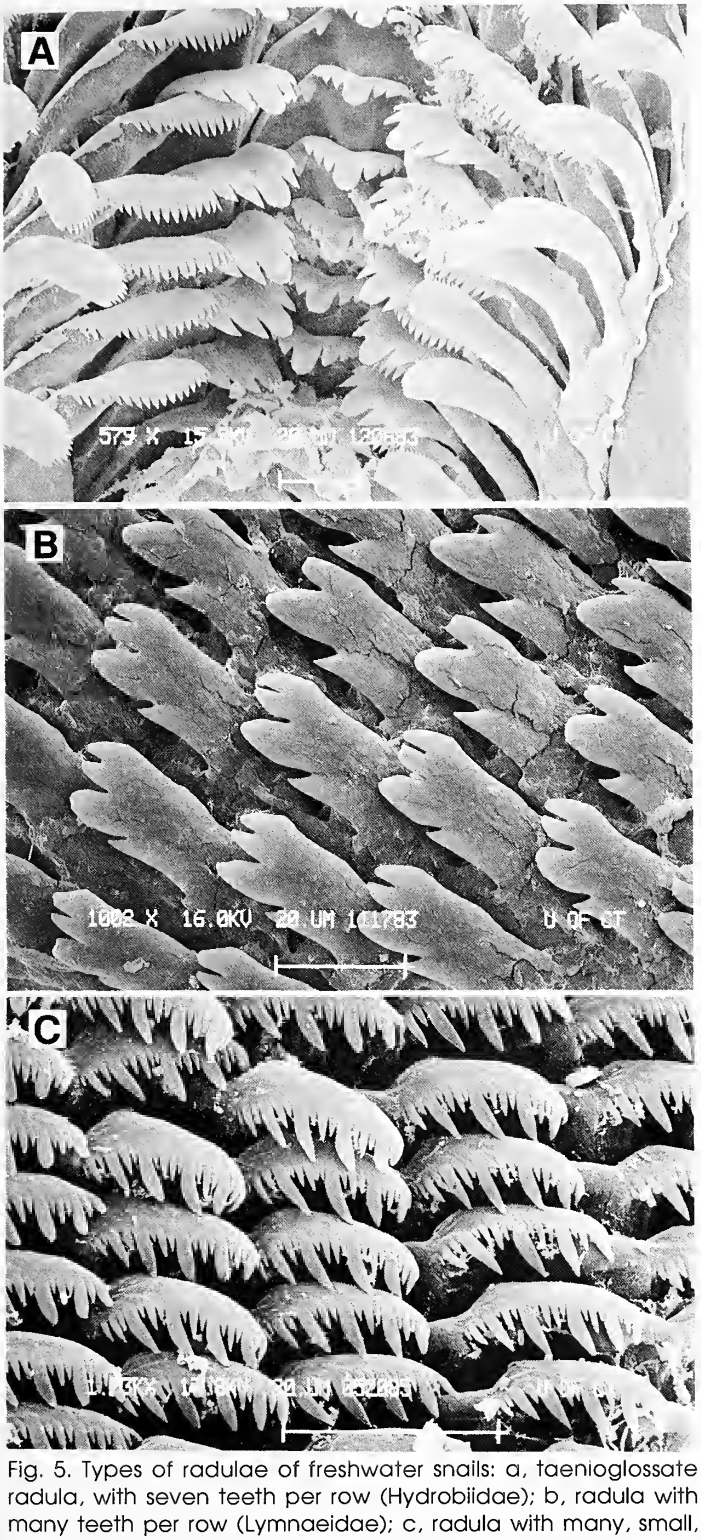


Fig. 5. Types of radulae of freshwater snails: a, taenioglossate radula, with seven teeth per row (Hydrobiidae); b, radula with many teeth per row (Lymnaeidae); c, radula with many, small, serrated teeth per row (Physidae).

505, 520, 523, 535); and Susquehanna River watershed (400). Populations are known to be common in the Oswego (St. Lawrence), Allegheny (Ohio-Mississippi), and Hudson River watersheds (Harman & Berg 1971, Strayer 1987).

Valvata tricarinata was first reported from New York by De Kay (1843). During the 19th century, the species was noted to exist in scattered localities across the State, from Albany County (Marshall 1895), west to Herkimer, Otsego, Onondaga, Cayuga, Monroe and Chautauqua Counties (Lewis 1856 a, b; 1860; 1872; Beauchamp 1886b; Walton 1891, 1898; Marshall 1894; Maury 1898; Baker 1899). Over the next 35 years, additional sites were added from Madison, Oswego, Cayuga, Schuyler, Niagara, Erie, and Chautauqua Counties (Baker 1900b, 1916a, b, 1918a, 1928b; Evermann & Goldsborough 1902; Henderson 1907; Letson 1909; Maury 1916; Pratt 1923; Fluck 1933). During this time, fossils of *V. tricarinata* were found in peat in Bronx County (Humphreys 1910) and in the Cayuga Valley (Maury 1916). Eastern sites were added for Warren, Greene, Dutchess, Manchester and Rockland Counties (Townes 1936, Jacobson 1945, Jacobson & Emerson 1961, Bretet & Carswell 1952). In western New York, Townes (1937) found the snail still present in Lake Chautauqua and in Findley, Bear, and Upper and Middle Cassadaga Lakes. Burdick (1939) noted *V. tricarinata* as common in Lake Ontario. Otsego, Onondaga, Cayuga, Seneca, Yates, Steuben, and Livingston Counties in central New York and Jefferson County in northern New York have been cited as having populations (Harman & Berg 1971; Harman 1970, 1971; MacNamara & Harman 1975; Wade & Vasey 1976; Buckley 1977; Wade 1987). Strayer's (1987) extensive survey has demonstrated this species to be common and widespread in the Hudson River basin.

Of the 22 sites sampled during this survey, eight were river and stream sites, nine were lakes, four were permanent ponds, and one was a marsh. In Connecticut and Massachusetts, *V. tricarinata* is found only in larger lakes and ponds (Jokinen 1983, Smith 1987). In other parts of its range, it also can inhabit slow rivers, small streams, intermittent streams, freshwater tidal marshes, stream backwaters, and muskeg pools (Goodrich 1932, Clarke 1981, Cvancara 1983, Strayer 1987). Populations can survive in shallow to deep water on many types of substrata, including aquatic vegetation, such as the algae *Cladophora* sp. and *Oedogonium* sp., and macrophytes and decaying terrestrial leaf litter (Baker 1918a, 1928b; Clarke 1973; Jokinen 1983).

The life cycle of *V. tricarinata* is annual. Eggs appear from March to July (Baker 1928b, McKillop 1985), with the time probably dependent on geographic location. Ten to 30 eggs in a gelatinous mass with a diameter of 1 mm are deposited on aquatic plants or stones (Baker 1928b,

Heard 1963). Newly hatched young float on the undersurface of the water film (Baker 1928a). Populations of *V. tricarinata* can be dense enough to be a dominant element in a lake's faunal biomass (Tudorancea *et al.* 1979).

Water chemistry values in New York State were: pH: 6.9-8.2 (7.5 ± 0.1), conductivity: 139-2320 µmhos/cm (433 ± 102), Ca^{++}: 4-89 ppm (28 ± 4), and Na^{+}: 1-291 ppm (36 ± 14). These values, as well as those from Connecticut (Jokinen 1983), southeast Manitoba (McKillop 1985), central New York (Harman & Berg 1971), and North Dakota (Cvancara 1983) indicate that *V. tricarinata* populations are limited to high calcium habitats.

Valvata sincera Say, 1824

Mossy valvata
Figs. 6b, 7

Shell yellowish-brown, subglobose-conic, 5 mm wide, solid; sculpture of fine and regular striae; umbilicus round, deep, exhibiting volutions almost to apex; whorls 4.0, evenly rounded, regularly increasing in diameter; sutures well-impressed; aperture circular; lip continuous, touching but not appressed to whorl above (Baker 1928a).

The various subspecies (*V. sincera sincera* Say, *V. sincera ontariensis* Baker, *V. sincera helicoidea* Dall) are distributed as a group from the Arctic Circle south to Connecticut and west to Minnesota (Baker 1928a; Bright 1981; Clarke 1973, 1981; Jokinen 1983; Smith 1987).

Only four living populations were located during this survey, all within the St. Lawrence River watershed (259A, 261, 263, 495). Sites 259A and 263 were different localities within Dead Creek, a marshy tributary of Lake Champlain. Lake Champlain was site 261, and 495 was the Oswego River, Oswego County. An additional site, Conesus Lake (505), Livingston County, St. Lawrence River watershed, had no living populations, but shells were found in the marl. Conesus Lake, used as a reservoir for the Genesee Valley Canal, was subject to repeated drawdown, which could have destroyed the valvatids.

Although *V. sincera* appears to be relatively rare in New York State, De Kay (1843) reported populations from Oneida Lake, Onondaga County; Lake Chautauqua, Chautauqua County; and Lake Champlain, Clinton County. Lewis (1856a, 1860, 1872) noted the species as rare and only present in the marshy borders and sediments of the "Little Lakes" in Herkimer and adjacent counties. During the late 19th and early 20th centuries, *V. sincera* was reported from Winfield in Herkimer County; the Erie Canal and "Wide Waters," Monroe County; Irondequoit Bay in Lake Ontario, Monroe County; Lime Lake in Cattaraugus County; Seneca River and Oneida Lake in Onondaga County; Cayuga Lake in Cayuga County; and Lake Chautauqua, Chautauqua County (Beauchamp 1886b; Marshall 1894; Walton 1898; Letson 1909; Maury 1916; Baker 1900b, 1918a, 1928b). More recently, additional populations were reported from Lake Ontario at Sodus Bay, Wayne County, and Little Sodus Bay, Cayuga County; Schroon River, Warren County; Hudson River, Greene County; Otsego Lake, Otsego County; Fifth Lake, Hamilton County; and the lower Hudson River in the vicinity of Dutchess County (Townes 1936, Burdick 1939, Jacobson 1945, Harman 1971, MacNamara & Harman 1975, Buckley 1977, Strayer 1987).

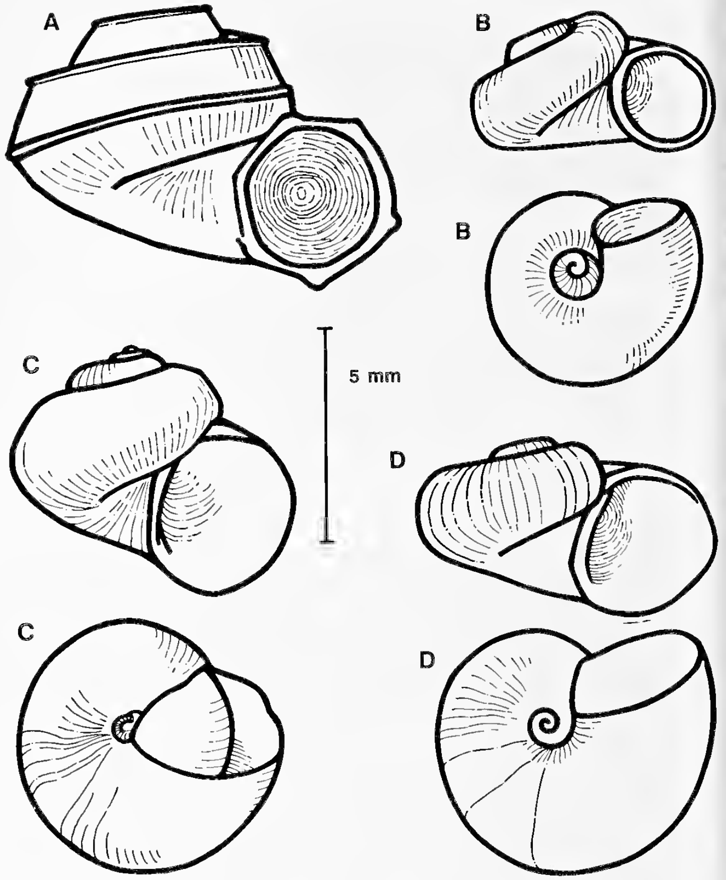


Fig. 6. Family Valvatidae, shells: a, *Valvata tricarinata*; b, *V. sincera*, two views; c, *V. piscinalis*, two views; d, *V. lewisi*, two views. All illustrations are drawn to the same scale.

This species, in southern New England and New York, is limited to large lakes and rivers (Jokinen 1983, Smith 1987, Strayer 1987, this study). In Canada, it also inhabits muskeg pools (Clarke 1981).

V. sincera is listed as endangered in Massachusetts (Smith 1987), and the present distribution in southern New England and New York is probably a relict of a broader early Holocene distribution (Smith 1987, Strayer 1987).

Populations can live at considerable depths and are associated with submerged aquatic vegetation (Clarke 1981). Of the five sites in New York, one is a river, three are lakes, and one is a marshy creek feeding into Lake Champlain.

The snails produce egg capsules, each containing two to six eggs, on aquatic plants (Lang & Dronen 1970). In Manitoba, young are present from May to July, and the species has

an annual life cycle (McKillop 1985). *V. sincera* forms part of the diet of whitefish, *Coregonus clupeaformis* (Mitchill), and perch, *Perca flavescens* (Mitchill) (Goodrich 1932, Clarke 1981).

Except for Fifth Lake in the Black River basin (Buckley 1977), this species usually lives in high calcium habitats. Water chemistry values for the five sites sampled during this survey are: pH: 6.9-7.4 (7.2 ± 0.1), conductivity: 142-905 µmhos/cm (431 ± 126), Ca^{++}: 13-44 ppm (35 ± 6), and Na^{+}: 7-117 ppm (34 ± 21). These values are similar to those in Connecticut (Jokinen 1983), central New York (Harman & Berg 1971), and Manitoba (McKillop 1985). It appears that in Canada *V. sincera* is limited to oligotrophic and mesotrophic lakes (Clarke 1979), but in Connecticut (Jokinen 1983) and New York, habitats can be eutrophic.

Valvata piscinalis (Müller, 1774)

European stream valvata
Figs. 6c, 7

Shell yellowish brown to greenish, shining, rather solid, 5 mm wide, about as high as wide; sculpture consisting of collabral threads; umbilicus narrow, deep; whorls up to 5.0, rounded; spire conical, apex obtuse; aperture circular, appressed to body whorl; inner lip reflected slightly over umbilicus (Clarke 1981).

This is an introduced Eurasian species that has spread throughout Lake Ontario, Lake Erie, the upper St. Lawrence River and its tributaries, and the lower Hudson River (Baker 1900b, Oughton 1938, Clarke 1981, Strayer 1987).

In New York, Baker (1900b), noting that the species had been seen first in 1897, recorded *V. piscinalis* (as "*obtusa*") as abundant in beach wash of Lake Ontario, Monroe County. Burdick (1939) later noted the species at a depth of 6-9.5 m in Oswego Harbor, Lake Ontario, Oswego County. Cayuga Lake, Tompkins County, also has a population (Harman 1968b, Harman & Berg, 1971).

Three populations were located during this survey, two in the Hudson River (96E, 286) and one in the St. Lawrence watershed (141). Strayer (1987) collected a few specimens from the tidal Hudson River in Dutchess County.

Valvata piscinalis occurs in lakes and slow moving rivers (Clarke 1981). Immediately prior to egg laying the snails leave the substratum and move to aquatic vegetation to deposit egg capsules containing 4-60 eggs. The young emerge in 15-30 days and feed on periphyton before they migrate down to the substratum (Cleland 1954, Clarke 1981).

Water chemistry values for sites 141 and 286 were: pH: 6.9 and 7.9, conductivity: 162 and 208 µmhos/cm, Ca^{++}: 13 and 29 ppm, and Na^{+}: 7 ppm at both sites.

Valvata lewisi Currier, 1868

Fringed valvata
Figs. 6d, 7

Shell turbinate, thin, 5 mm wide, regularly striate; spire depressed, apex flattened; whorls 3.5, rapidly enlarging; lip thin, continuous, appressed to body whorl above; umbilicus wide, deep, exhibiting interior whorls (Baker 1928a).

This species occurs in southern Canada from Quebec to British Columbia and in the United States from New York west to Minnesota (Goodrich 1932, Burch 1982).

Only one population of this species was located during this survey. It was in a ditch at Oneida Shores County Park, Onondaga County, St. Lawrence River watershed (450). The only population found by Harman & Berg (1971) in central New York was in Oneida Lake.

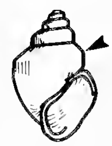
In Oneida Lake, *V. lewisi* was relatively scarce, living on sand down to depths of 7 m (Harman & Berg 1971). Other substrata include mud and aquatic vegetation (Baker 1928a).

Family Viviparidae

Shell turbinate, moderately large, imperforate or subperforate; whorls convex, often carinate; aperture entire, subcircular or somewhat applied above; lip simple; operculum convex, concentric; nucleus subcentral; rostrum long; tentacles long, slender; male right tentacle short, wide, forming penis sheath; uterus large, filling much of last whorl; females ovoviviparous; snails in mid-neanic stage when born (Baker 1928a); *shells of developing viviparids marked by spiral rows of periostracal hairs and/or ridges* (Jokinen 1984).

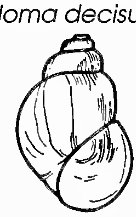
Key to the Viviparidae

1a. Shell with distinct angulations or ridges on whorls .... *Lioplax subcarinata*



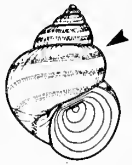
1b. Shell without distinct, sharp angulations 2

2a. Inner lip not reflected, not forming an umbilicus .... *Campeloma decisum*



2b. Inner lip reflected, forming a slit-like umbilicus 3

3a. Shell striped with chestnut-colored bands, sometimes visible only inside shell aperture ....*Viviparus georgianus*



3b. Shell not striped......................*Cipangopaludina* spp., 4

4a. Shell apex obtuse, without spiral angulations, often with surface malleation ....*Cipangoplaudina chinensis*

4b. Shell apex acute, with low angulations on whorls, without malleations..................*Cipangopaludina japonica*

Viviparus georgianus (Lea, 1834)

Banded mysterysnail
Figs. 7, 8a

Shell subglobose, moderately large, up to 45 mm high, imperforate or with narrow, slit-like umbilicus; whorls 4.0-5.0 with 4 spiral, chestnut-colored bands (possibly obliterated outside but always visible inside); sutures deep; outer lip thin; parietal lip a thickened glaze; operculum roundly ovate, concentric (Baker 1928a, Clench 1962, Clench & Fuller 1965); *newly released young with 3 spiral rows of hooked hairs on apical and second whorls and 11-13 rows on third whorl* (Jokinen 1984).

A common synonym is *Viviparus contectoides* (Binney 1863).

This species occurs east of the Mississippi River, from southeastern Canada to Florida and the Gulf of Mexico. It has extended its range northeasterly since the middle of the 19th century (Richards 1934, Clench 1962, Harman & Berg 1971, Clarke 1981, Jokinen 1983, Smith 1987, Strayer 1990).

Thirty-two populations of *V. georgianus* were found in all major New York drainage basins except the Delaware. Localities were in the Hudson River watershed (280, 284, 293, 318, 319, 320, 610); Mississippi-Ohio River watershed (427B); St. Lawrence River watershed (141A, 141C, 262, 307, 338, 339, 341, 353, 358, 377, 407, 408, 409, 410, 448A, 502A, 505, 510, 512, 513, 521, 562); Susquehanna River watershed (592); and Housatonic River watershed (294). Populations also have been reported from scattered localities in the Susquehanna, Oswego and Genesee (St. Lawrence), and Mohawk River watersheds (Harman & Berg 1971, Wade & Vasey 1976, Strayer 1987).

De Kay (1843) did not list *V. georgianus* as occurring in New York State. The species was introduced into New York in 1867 when J. Lewis deposited 200 individuals from Illinois into the Erie Canal and Mohawk River in Herkimer County (Lewis 1872, Clench 1962). As of 1961, it had not yet migrated to Peekskill or Long Island, but it had extensively populated a pond in New York City's Central Park, New York County (Jacobson & Emerson 1961). Robertson (1933) reported the species from Buffalo. The New York State Museum has specimens collected during the 1950s and 1960s from Cayuga, Genesee, Herkimer, Madison, Monroe, Oneida, Onondaga, Ontario, Oswego, Tompkins, and Wayne Counties.

Of the 32 populations located during this survey, six were in river and stream sites, 14 in lakes, nine in permanent ponds, two in marshes, and one in a ditch. None of the habitats were ephemeral.

In temperate lakes, females bear young their second summer and live to three years. They grow larger than males, which die during their second summer after a period of reproduction. The snails migrate to shallow water in midsummer and to deeper water in October (Jokinen *et al.* 1982). Fecundity varies from 4-81 embryos/female (Vail 1978, Browne 1978, Jokinen *et al.* 1982).

The New York populations existed in water with pH: 6.3-8.5 (7.3 ± 0.1), conductivity: 42-452 µmhos/cm (225 ± 21), Ca^{++}: 3-36 ppm (18 ± 2), and Na^{+}: 2-40 ppm (12 ± 2). This species appears to have a relatively wide tolerance range for soft and hard water habitats.

Cipangopaludina japonica (von Martens, 1861)

Japanese mysterysnail
Figs. 7, 8b

Shell somewhat extended, up to 65 mm high, olivaceous green to dark brownish green, without banding, rimately umbilicate; whorls 7.0-8.0, strongly convex; spire extended, produced at 50-55° angle; outer lip thin; parietal lip with thin glaze; operculum thin, nucleus submarginal (Clench & Fuller 1965).

This is an oriental species found in Japanese mesotrophic and eutrophic lakes and ponds (Taki 1981). It was introduced into North America, where there are now scattered populations (see review in Jokinen 1982).

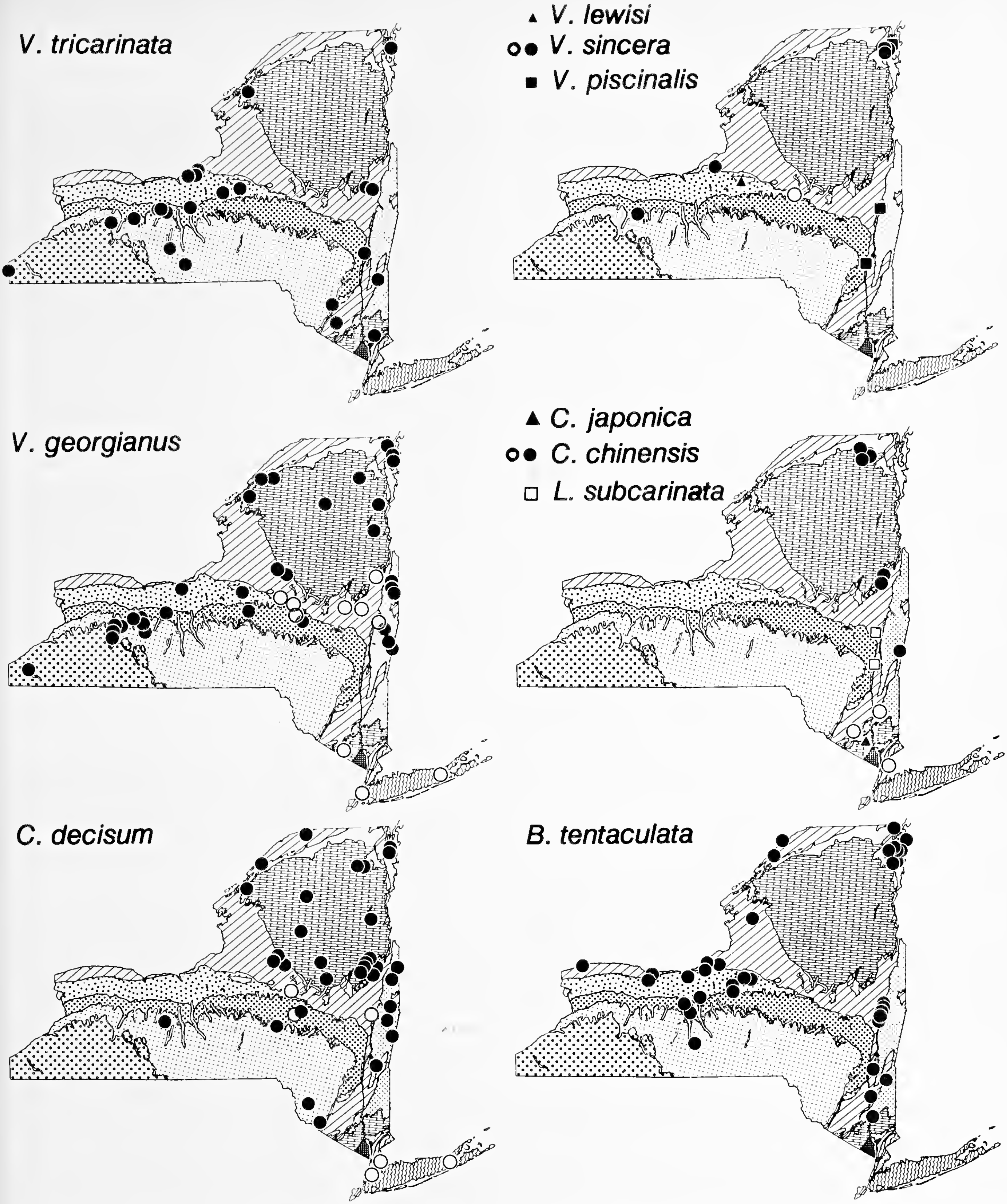


Fig. 7. Known distributions of species of Valvatidae, Viviparidae, and Bithyniidae in New York State. Closed circles indicate records from the present survey, and open circles indicate records from museum specimens.

Lake Tiorati (site 607, Hudson River watershed), a soft water lake in the Palisades Interstate Park, Orange County, has the only population found during this survey.

Females can survive up to eight years and carry 10-120 developing embryos. Young are released from late April, when water temperatures reach 15°C, until October. In Japan, the snails hibernate in mud from December through February (Taki 1981).

Little is known of the habitat parameters of this species. Lake Tiorati has soft water: pH: 6.3, conductivity: 62 μmhos/cm, Ca^{++}: 11 ppm, and Na^{+}: 16 ppm. A Connecticut population lives in a lake of medium hard water: pH: 7.3, conductivity: 194 μmhos/cm, Ca^{++}: 11 ppm (Jokinen 1983).

Cipangopaludina japonica was synonymized with *C. chinensis* by Dundee (1974), and Clarke (1978), and Strayer (1990) agreed. Others have not synonymized these species (Clench & Fuller 1965, Smith 1987), or have recognized them as different phenotypes (Jokinen 1982).

Cipangopaludina chinensis (Gray, 1863)

Chinese mysterysnail
Figs. 7, 8c

Shell large, to 60 mm high, uniform light to dark olive-green to brown, without banding; sculpture of fine growth lines, spiral lines, and malleations; umbilicus small, round, covered in part by reflected parietal lip; whorls 6.0-7.0, slightly shouldered; spire moderately extended, produced at 65-70° angle; sutures deep; outer lip slightly reflected, entire lip colored black; operculum corneous, thin, with concentric growth lines, nucleus submarginal (Clench & Fuller 1965); *spiral lines of periostracal hairs conspicuous in young* (Jokinen 1984), *resulting in rows of pits on many adult shells. Growth allometric, young with lower height to width ratio and sharply angled body whorl* (Jokinen 1982).

A commonly used synonym is *Viviparus malleatus* (Reeve 1863).

This is an Asian species introduced into North America in the Chinese markets of San Francisco as a food item (Abbott 1950). It has spread across the United States, north to Montreal, and it is abundant on the northeast coast up to New Hampshire (Jokinen 1982). Accounts of *C. chinensis* in New York and New England are found in Jacobson & Emerson (1961), Clench & Fuller (1965), Dundee (1974), Jokinen (1983), Smith (1987), and Strayer (1990). Harman and Berg's (1971) survey of central New York State did not reveal any populations.

Six populations of *C. chinensis* were found during this survey in the Hudson River watershed (295, 297) and the eastern St. Lawrence River watershed (298, 311, 349, 351). Additional populations have been reported from the Black River (Buckley 1977) and Hudson River basins (Buckley 1977, Strayer 1987). Sites in Westchester, Orange, Dutchess, Queens, and Nassau Counties are noted in Clench and Fuller (1965).

No populations were reported in New York prior to 1942, at which time the snail was found in the Niagara River, Niagara County (Schmeck 1942). The species had not populated central New York by the early 1970s (Harman & Berg 1971) but had been introduced into Oneida Lake by 1978 (Clarke 1978).

Female snails have a five year life span, but most males die after three years, with a few surviving to four years. Growth continues throughout life; and females grow larger than males. They begin to produce young ovoviviparously at the end of their first year, but maximum productivity is not reached until the fourth and fifth years. Newborn appear from June through October (Stańzykowska *et al.* 1971). The snails are found in shallow water during summer, where they feed primarily on epibenthic diatoms on muddy to sandy sediments (Stańzykowska *et al.* 1972). The animals migrate to deeper water in the autumn (Stańzykowska *et al.* 1971).

This species lives in permanent lakes and quiet embayments of rivers (Jokinen 1982). Three New York populations occurred in lakes and three in ponds. Chemical conditions were: pH: 6.5-7.8 (7.0 ± 0.2); conductivity: 63-400 μmhos/cm (165 ± 56); Ca^{++}: 5-16 ppm (10 ± 2); and Na^{+}: 2-49 ppm (13 ± 7). These are similar to the parameters for Connecticut populations (Jokinen 1983). *C. chinensis* appears to be limited to waters of medium to high calcium and pH values.

Campeloma decisum (Say, 1816)

Pointed campeloma
Figs. 7, 8d

Shell elongate-oval, 40 mm high, thin, dark green or olive to brown; imperforate; whorls 6.0, early ones usually eroded; spire long and pointed, sharply conic; operculum thick, entirely concentric (Baker 1928a).

Clarke (1981) and Burch (1986) list *C. integrum* (Say 1821) as a synonym.

This species ranges from Nova Scotia and New England west to Manitoba and Minnesota, south to Kentucky, Tennessee, Virginia, and Louisiana (Baker 1928a, Goodrich 1932, Richards 1934, Clench 1962, Clarke 1981, Jokinen 1983, Branson *et al.* 1987, Smith 1987, Brown *et al.* 1989). The range might extend into North Dakota, but only shells have been collected (Cvancara 1983).

In New York State, *C. decisum* occurs in the Delaware River watershed (457, 466); Hudson River watershed (212, 284, 292, 293, 297, 303, 304, 305, 317, 320, 321, 367, 384, 386, 612); St. Lawrence River watershed (141C, 141D, 262, 298, 338, 339, 345, 352, 353, 354, 363, 366, 377, 517); and the Susquehanna River watershed (583, 591). Older specimens in the New York State Museum are from Riverhead and Greenport, Suffolk County, Long Island (NYSM 27825-27828, 29942, 29943), Oneida County (NYSM 29944, 29946), Schuylers Lake, Otsego County (NYSM 31040), and Lake

Erie (NYSM 31041). Populations were found in all major drainages of New York except the Allegheny (Mississippi-Ohio), but they appear to be more plentiful in the northeastern part of the State. This species is abundant in the basins of the Mohawk and Hudson Rivers (Strayer 1987) and the Oswego-St.Lawrence basin, with only scattered accounts from the Susquehanna watershed (Harman & Berg 1971).

The first mention of *C. decisum* in New York was made by De Kay (1843), who noted it to be the most common species in the State. Lewis (1856a, b; 1860; 1868; 1872; 1874) found populations in the Erie Canal and in rivers and lakes of Herkimer and Otsego Counties. In a series of papers from the late 19th through the early 20th centuries populations were recorded from the Erie Canal, Oneida and Monroe Counties (Baily 1891; Walton 1891, 1898; Marshall 1886); Canandaigua Lake, Ontario and Yates Counties (Mitchell 1899; Maury 1916); Chautauqua Lake, Chautauqua County (Maury 1898, 1916; Evermann & Goldsborough 1902; Townes 1937); Owasco Lake and Owasco River, Cayuga County (Baker 1899); Hudson River, Washington County (Pilsbry 1897); Onondaga County (Beauchamp 1886b); Albany, Albany County, and Troy, Rensselaer County (Marshall 1895); Genesee River, Monroe County (Baker 1900b, 1901); Riverhead, Suffolk County, Long Island (Smith & Prime 1870); Niagara River, Niagara County, and Lake Erie (Letson 1909), Oneida Lake (Baker 1916a, 1916b, 1918a; Pratt 1923); Cayuga Lake, Cayuga County; and Conesus Lake, Livingston County (Maury 1916).

More recent records of *C. decisum* are from Conesus Lake, Livingston County (Robertson & Blakeslee 1948; Wade 1980, 1987; Wade & Vasey 1976); Lake Ontario (Burdick 1939); Warren County (Jacobson 1945); Hudson River from Hudson, Greene County, to Port Ewen, Ulster County (Townes 1937); Mohawk River (Strayer 1987); lakes in the Allegheny watershed, Chautauqua County (Townes 1937); Finger Lakes (Harman & Berg 1971); and the Black River, Lewis, Jefferson, and Oneida Counties (Buckley 1977). The New York State Museum has lots collected from 1955-1966 from Cayuga, Essex, Madison, Monroe, Onondaga, Ontario, Schuyler, Seneca, Tioga, Tompkins, and Wayne Counties.

Of the 33 populations found during this survey, six were in river and steam sites, 20 in lakes, five in permanent ponds, one in a marsh, and one in a canal. *C. decisum* is a burrowing snail, and it is usually located within the top several centimeters of soft sediments such as sand, clay, silt and detritus (Baker 1918a, 1928a; Goodrich 1932; Dawley 1947; Clench 1962; Harman & Berg 1971; Clarke 1973; Jokinen 1983; Smith 1987; Strayer 1987).

The animals appear to feed by ingesting sediment containing decaying organic matter (Chamberlain 1958, Imlay *et al.* 1981). Newly born snails are often found wedged in rock crevices rather than in sediment (Jokinen 1983). Temperate zone populations contain no males, and reproduction is by ovoviviparous parthenogenesis (Mattox 1938, van der Schalie 1965, Selander *et al.* 1977).

Individuals from temperate zone populations have life spans of three to five years, with reproduction beginning in the second year (Medcof 1940, Chamberlain 1958, Imlay *et al.* 1981). Subtropical populations in Louisiana have shorter life spans, usually two years, with some females surviving to three years. By age 1.5 years, females are brooding embryos that are released by the second year. Males, smaller than females of the same age, exist in the subtropical populations but are outnumbered by females three to one (Brown *et al.* 1989). In the subtropical populations, *C. decisum* has demonstrated very high secondary productivity as expressed by biomass (Richardson & Brown 1989).

This species is common in lakes and rivers in the northeastern United States, and it lives within a wide range of chemical parameters. Water chemistry values for 31 sites sampled during this survey are: pH: 5.8-9.2 (7.0 ± 0.1), conductivity: 28-368 μmhos/cm (125 ± 16), Ca^{++}: 1-37 ppm (11 ± 2), and Na^{+}: 1-40 ppm (7 ± 2). In central New York, pH values for 21 sites were 7.3-8.5 (7.9) (Harman & Berg 1971). Connecticut values for 40 sites were: pH: 5.8-10.0, conductivity: 38-286 μmhos/cm, Ca^{++}: 1-27 ppm, and Na^{+}: 1-22 ppm (Jokinen 1983).

Lioplax subcarinata (Say, 1816)

Ridged lioplax
Figs. 7, 8e

Shell ovate, 20 mm high, thin to thick, pale brownish green to olivaceous; finely umbilicate; whorls 6.0; spire whorls usually carinate, body whorl not carinate; spire and aperture equal in length; apex sharp in young, truncated in older shells; sutures deep; outer lip thin; inner lip callus on parietal wall; operculum distinct with spiral nucleus and concentric periphery (Baker 1928a, Clench & Turner 1955).

This species is found on the Atlantic coast from New York south to North Carolina (Richards 1934, Clench 1962, Clench & Turner 1955, Branson *et al.* 1987).

Populations were not located during a recent survey of the Hudson River basin (Strayer 1987), nor during this survey.

Lioplax subcarinata was first collected in New York State by Beecher in 1878 at the mouth of the Normans Kill, Albany County (Marshall 1895) (NYSM 31043). This species might have migrated into the Hudson from the Delaware River via the Delaware and Hudson Canal (Lewis 1874). Beauchamp (1886b) located it in the Erie Canal, Onondaga County, and in the Hudson River. The most recent collection was that of Townes (1936), who found the snails to be common on the mud bottom of the Hudson River from Hudson, Greene County, to Port Ewen, Ulster County. The University of Michigan Museum of Zoology, Museum of Comparative Zoology at Harvard University, and The

Academy of Natural Sciences of Philadelphia have specimens from the Hudson River in Greene and Dutchess Counties and from the Normans Kill (Hudson River watershed), Albany County.

Populations of *L. subcarinata* dwell in lakes and rivers on mud, sand, and gravel in water depths up to 1 m and in a wide range of current speeds (Clench & Turner 1955; Clench 1962).

Little is known of the life history of this snail, but data are available for a midwestern *Lioplax* species, *L. sulculosa* Menke. Females live two years, begin to bear young the first year, and release one brood a year. Males are smaller than females of the same age and live only one year (van Cleave & Chambers 1935).

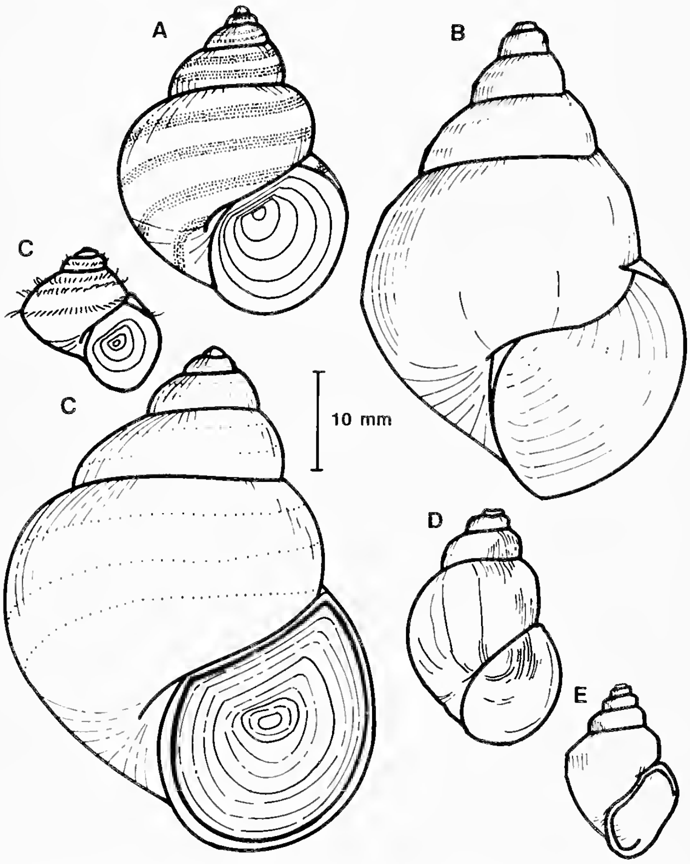


Fig. 8. Family Viviparidae, shells: a, *Viviparus georgianus*; b, *Cipangopaludina japonica*; c, *C. chinensis*, with immature individual shown to the upper left; d, *Campeloma decisum*; e, *Lioplax subcarinata*. All illustrations except for the immature are drawn to the same scale.

Family Bithyniidae

Shell ovate, conical or turbinate, up to 12 mm long; spire produced; umbilicus imperforate; whorls 5.0-6.0, somewhat flattened; aperture oval, continuous; lip thickened; operculum calcareous, spiral when young, concentric when adult, never withdrawn into body whorl; foot simple, with right cervical lobe forming water conduit; tentacles long, pointed, tapering; dioecious; verge bifid; eggs deposited in double-rowed clusters (Baker 1928a, Berry 1943, Fretter & Graham 1962).

Bithynia tentaculata (Linnaeus, 1758)

Mud Bithynia
Figs. 7, 9a

Synonyms include *Bythinia tentaculata* (L.) and *Bulimus tentaculatus* (L.).

This species was introduced into North America from Europe and is now distributed in the Great Lakes - St. Lawrence drainage system, from Quebec west to Wisconsin (Baker 1928a, Berry 1943, Clarke 1981) and in the Mohawk and Hudson Rivers (Strayer 1987). It does not occur in southern New England (Jokinen 1983, Smith 1987) or Lake Superior (Berry 1943; Jokinen, unpublished data).

Populations of *B. tentaculata* were found at 39 sites during this survey: Hudson River watershed (96A, 96D, 96E, 96F, 96G, 96H, 96I, 286, 290, 603), and St. Lawrence River watershed (141A, 259A, 259B, 260, 261, 262, 263, 264, 308, 332, 340, 343, 398, 441, 445A, 445C, 448A, 448B, 450, 493, 494, 495, 497, 499, 502A, 524A, 524B, 527, 531).

It is possible that this species had a double origin in North America. Baker (1928a) notes "there is no doubt that this common European species was introduced into America from Europe in the ballast of the timber ships...." However, Pleistocene fossils of *B. tentaculata* were unearthed in sediments of Glacial Lake Chicago, indicating the species had been in North America for thousands of years. The possibility that the American populations remained extant and interbred with the European form is not established (Baker 1928a).

Beecher collected several hundred specimens from the Champlain Canal in 1879 and deposited them in the New York State Museum (Marshall 1894). The first published report of *B. tentaculata* occurring in New York is that of Beauchamp (1886b), who noted the species had been in Lake Ontario at Oswego, Oswego County, since 1879 and was abundant in Lake Ontario at Syracuse, Onondaga County. The species was in the Champlain Canal at West Troy, Saratoga County, by the 1880s (Ancey 1887). *B. tentaculata* quickly became the most abundant species in the Erie Canal at Syracuse, Onondaga County, where it seemed to be driving out the native pleurocerids, *Goniobasis virginica* and *G. livescens* (Beauchamp 1887, 1891).

By the turn of the century, *B. tentaculata* was in Monroe County in the Erie Canal and "Wide-Waters" at Rochester, the Genesee River below the falls, Irondequoit Bay in Lake Ontario, and it was collected among beach wash at Lake Ontario (Walton 1891, 1898; Baker 1900a, 1901). It soon was reported from the western end of the Erie Canal (Letson 1909); Cayuga Lake, Cayuga and Seneca Counties;

the Seneca River at Waterloo, Seneca County (Maury 1916); Oneida Lake, Oswego and Onondaga Counties (Baker 1916a, b, 1918a; Pratt 1923); the Hudson River from Hudson to Staatsburg, Columbia County (Townes 1936); and Oswego Harbor in Lake Ontario, Oswego County (Burdick 1939). Prior to 1960, Jacobson & Emerson (1961) located populations in Canopus Creek and other local streams at Annsville, near Peekskill, Westchester County. By 1970, *B. tentaculata* was established in Seneca Lake, Yates and Seneca Counties; Cross Lake, Cayuga and Onondaga Counties (Harman & Berg 1970); and in the Black River, Jefferson County (Buckley 1977). At present, this species is abundant in the intertidal zone of the Hudson River, Dutchess and Ulster Counties (Strayer 1987).

During this survey, populations were found at 15 river and stream sites, 15 lake sites, two permanent ponds, a ditch at the edge of Oneida Lake, four marshes, and two canal sites. No populations were found in ephemeral habitats.

Bithynia tentaculata lives on a variety of substrata. In Oneida Lake, it is active on gravel, sand, clay, mud, and the exposed undersides of rocks (Baker 1918a, Mattice 1972). In any one area, most of the snails often are on macrophytic vegetation (Harman 1968a, Vincent *et al.* 1981, Bronmark 1988). Water depths are usually shallow (Vincent 1981, Vincent *et al.* 1981, Strayer 1987) but can go as deep as 5 m (Baker 1918a). Individuals living on macrophytes migrate down from the plants to the substratum from September to December but do not appear to make deep to shallow water migrations (Vincent *et al.* 1981).

The life span of this species seems to vary with climate. In Oneida Lake, New York; northwestern England; and Lac St-Louis, Montreal, the snails live 17-18 months (Mattice 1972, Dussart 1979, Pinel-Alloul & Magnin 1971). In a study of several local populations of *B. tentaculata* in the St. Lawrence River at Quebec, Vincent & Vaillancourt (1981), calculating snail age by annual growth lines and not by histograms, demonstrated a 32-39 month life span. The discrepancies could be due to environmental differences or incorrect estimates by researchers.

Ovipositing times differ among localities. Egg-laying can begin in May or June and continue into July (Pinel-Alloul & Magnin 1971, Mattice 1972, Vincent *et al.* 1981). In some populations, there is a second egg-laying period in October and November by grown females born in the spring (Pinel-Alloul & Magnin 1971). Spring oviposition begins when the water temperature reaches 20°C, and eggs are deposited on rocks, wood, and shells of living and dead molluscs (Vincent *et al.* 1981). In Oneida Lake, females lay eggs in double-rowed masses at densities of up to 155 masses/m^2 of rock substratum (Mattice 1972). Eggs masses contain 1-77 eggs, with a mean of 13 eggs (Vincent & Gaucher 1983).

Females reach minimum shell length of 6 mm before depositing eggs. All those greater than 8 mm carry eggs. Where females live more than one year (e.g., in the St. Lawrence River), fecundity is greatest in the two-year class, from which 65-74% of the eggs originate. The highest measured fecundity is 347 eggs/female. Even in the St. Lawrence River study area, considerable variation existed between populations (Vincent & Gaucher 1983).

In warmer climates, eggs hatch in three to four weeks (Mattice 1972) but can take two to three months in colder water (Vincent *et al.* 1981). Young hatch when shell length reaches 0.8 mm (Mattice 1972, Vincent *et al.* 1981), and they grow approximately 0.5 mm per week throughout the summer (Pinel-Alloul & Magnin 1971). Growth rates differ among populations, but, in general, they slow in August, and growth ceases from September through May (Vincent *et al.* 1981). In some populations, however, snails hatch in October and grow during the winter (Pinel-Alloul & Magnin 1971). In populations where snails live for three years, most linear growth is achieved in the first two years and only 10% in the third year. Weight increase is maximal during the second year (Vincent *et al.* 1981).

Densities vary from population to population, with the seasons, and from year to year (Vincent *et al.* 1981). Mattice (1972) counted up to 80 snails/m^2 in Oneida Lake. *B. tentaculata* makes up 48% of the gastropods in the Upper Estuary of the St. Lawrence River at Gentilly, Canada (Vincent 1979) and 32% of the total benthic fauna of the St. Lawrence at Quebec (Vincent 1981)

The genus *Bithynia* is capable of filter feeding. Snails draw water in between the mantle cavity and the body mass on the left side. Nutrient particles are packaged in mucous "sausages" which are extruded in a furrow between the right tentacle and the exhalant siphon. As the sausage is extruded, it is grasped by the snail's mouth and swallowed. This feeding mode allows populations to be dense on solid substrata because the snails are not dependent upon grazing (Meier-Brook & Kim 1977).

Bithynia tentaculata possibly competes with species of Pleuroceridae (Beauchamp 1887, 1891; Harman 1968a). In areas of New York State where this species has become densely populated, such as Oneida Lake, the pleurocerids have disappeared. In habitats like Cayuga Lake, where individuals are in low numbers, this species co-exists with pleurocerids (Harman 1968). Two decades after Harman's survey, *B. tentaculata* has not been found in Cayuga Lake (site 535), but the pleurocerid *Goniobasis livescens* remains.

These snails tend to live in habitats with relatively high calcium. Chemistry values for this survey were: pH: 6.6-8.4 (7.4 ± 0.1), conductivity: 87-2320 µmhos/cm (567 ± 93), Ca^{++}: 5-89 ppm (32 ± 4), and Na^{+}: 4-291 ppm (53 ± 12). *B. tentaculata* is especially tolerant of high sodium values, reflecting its ability to survive in the intertidal reaches of the lower Hudson River. The pH values are similar to those found by Harman & Berg (1971). In northwestern England, distribution correlates positively with stone substratum and potassium concentration, and it correlates negatively with nitrate concentration (Dussart 1979).

Family Hydrobiidae

Shell dextral, conical or attenuated; umbilicus perforate or imperforate; whorls 4.0-8.0; aperture entire; peristome usually continuous; operculum corneous, paucispiral or centrally multispiral with paucispiral periphery; foot longer than wide, rounded posteriorly; tentacles long, usually cylindrical, with eyes at base; dioecious; verge exerted, arising from posterior surface of head, near mantle margin, median or slightly to right (Berry 1943).

Key to the Hydrobiidae

This key is based primarily on shell characteristics (except for couplet 10). If possible, confirmations should be made using the anatomy of the verges, which are illustrated with the shells in Figs. 9 & 10).

1a. Apex truncate; nuclear whorl sunken below following whorl .... *Probythinella lacustris*

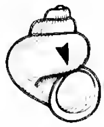
1b. Apex not truncate 2

2a. Operculum multispiral in center...................................... 3

2b. Operculum paucispiral 4

3a. Aperture of mature snails not attached to whorl above .... *Amnicola (Lyogyrus) pupoidea*

3b. Aperture attached to whorl above .... *Amnicola (Lyogyrus) grana*



4a. Umbilicus imperforate or a narrow slit 5

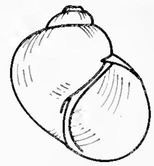
4b. Umbilicus perforate 7

5a. Whorls flattened; sutures shallow; shell 3 mm high .... *Pyrgulopsis letsoni*

5b. Whorls rounded 6

6a. Shell elongate .... *Fontigens nickliniana*

6b. Shell globose .... *Gillia altilis*



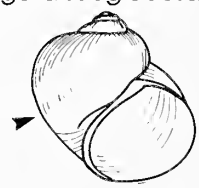
7a. Shell elongate, < 6 mm high .... *Pyrgulopsis lustrica*

7b. Shell conical 8

8a. Apex blunt; nuclear whorl in same plane as following whorl .... *Amnicola limosa*

8b. Apex pointed; nuclear whorl above following whorl .. 9

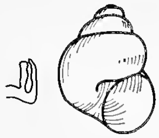
9a. Body whorl very large compared to preceding whorls; shell 9 mm high .... *Birgella subglobosa*



9b. Body whorl not inflated 10

10a. Shell up to 6 mm high; verge bifid with accessory lobe six times size of penis .... *Cincinnatia cincinnatiensis*

10b. Shell tiny, up to 3 mm high; verge bifid with accessory lobe approximately same size as penis .... *Amnicola walkeri*



Probythinella lacustris (F.C. Baker, 1928)

Delta hydrobe

Fig. 9b

Shell globose, 3 mm high; umbilicus wide, deep, conspicuous; spire truncated; first and second whorls planorboid, sunken below third whorl; apex blunt or truncate; whorls 4.0; sutures deep; aperture subovate; peristome continuous, adnate to body whorl for short distance, occasionally detached; columella reflected; verge bilobed, without accessory duct in secondary lobe (Fig. 9b) (Baker 1928a, Berry 1943).

Synonyms include *P. binneyana* (Hannibal 1913) and *Amnicola binneyana* Hannibal 1913.

Probythinella lacustris populations occur from Quebec west to the Northwest Territories (Baker 1928a, Berry 1943, Clarke 1981, Cvancara 1983). The Hudson River basin is the southeast limit of the range (Strayer 1987).

There are few references to this species in the literature.

Lewis (1868, 1872) found a colony in the Mohawk River, Mohawk, Herkimer County. Beauchamp (1886b) found the species in the Erie Canal, Onondaga County, but noted it as rare, and Baker (1900b) collected shells in beach wash from Lake Ontario, Monroe County. Collections from the Mohawk River and Erie Canal, Herkimer County, made from 1867 through 1936 by R. Call, T. Aldrich, C. Beecher, and J. Lewis, are housed in the Harvard University's Museum of Comparative Zoology, the University of Michigan Museum of Zoology, and the University of Florida. Harman & Berg (1971) reported finding one individual, referred to as *Amnicola binneyana*, in Seneca Lake, Ontario County.

Populations of this species were not found during the present survey.

It appears that *P. lacustris* is most abundant in water greater than 3 m deep, and the specimen found by Harman and Berg (1971) was at 16 m. In the Great Lakes, this species makes up the main diet of whitefish, *Coregonus clupeaformis* (Mitchill). Substrata include sand and marl with or without vegetation (Berry 1943). In North Dakota, populations occur in permanent streams 1-37 m wide (Cvancara 1983). Canadian populations are found among vegetation in permanent lakes, ponds, and streams. At its southern range, the species tends to occur in deeper water (Clarke 1981). The diet of this species is primarily diatoms (Berry 1943).

In North Dakota, *P. lacustris* is tolerant of high alkalinity. Water chemistry parameters cited by Cvancara (1983) were: pH: 8.0-9.2, conductivity: 895-3600 µmhos/cm, and Ca^{++}: 50-320 ppm (Cvancara 1983).

Gillia altilis (I. Lea, 1841)

Buffalo pebblesnail

Fig. 9c

Shell conico-globose, 6-8 mm high, light yellow-green; umbilicus rimate to imperforate; apex usually eroded; whorls 2.0-4.0 in eroded shells of adults, 4.5 in uneroded shells; whorls shouldered below suture; aperture broadly ovate-auriculate; peristome dark rimmed, complete across parietal wall by thin callus; outer lip conspicuously arched forward in lateral profile; operculum oval, chitinous, yellow-green, paucispiral (Thompson 1984b).

This species occurs in the Atlantic drainage system of the eastern United States, from New York and Vermont south to South Carolina. It entered the Lake Ontario system and moved west via the Erie Canal (Richards 1934, Thompson 1984b).

No populations were located during this or Strayer's (1987) survey.

In the past, this species has been found in the Erie Canal, Onondaga and Herkimer Counties (Beauchamp 1886b; Walton 1891, 1898); the Albany/Troy area and the Hudson River, Albany and Rensselaer Counties (Marshall 1895); and the Hudson River from Barrytown south to Straatsburg, Dutchess County (Townes 1936). Shells have been found in beach wash from Lake Ontario, Monroe County (Baker 1900b); Oneida Lake, Oswego and Onondaga Counties (Baker 1916a, b; 1918a, b); and the Salmon River, Oswego County (Burdick 1939). Thompson (1984b) cites the following localities determined from museum lots: Hudson River, Albany, Dutchess, and Ulster Counties; Erie Canal, Herkimer and Onondaga Counties; Champlain Canal, Rensselaer County; Niagara Falls, Niagara County; Monroe County; and Wayne County. The New York State Museum has lots from the Hudson River, Albany County (NYSM 31059, 31060).

In the Hudson River, *G. altilis* lives on mud and aquatic plants in shallow water (Townes 1936).

Birgella subglobosa (Say, 1825)

Globe siltsnail

Fig. 9d, 11

Shell subglobose to globose, 10 mm high; tan to gray; umbilicus narrow, deep; spire broad, depressed, usually shorter than aperture; apex slightly raised above second whorl; whorls 4.5, convex, rapidly increasing in diameter, shouldered; body whorl large, roundly ovate; peristome sharp, thin, continuous, flattened and appressed to parietal wall; operculum paucispiral; verge compressed, bifurcate; penis dark, shorter than globose secondary lobe, without accessory duct in secondary lobe (Baker 1928a, Berry 1943, Thompson 1984b).

Some authors have placed this species in the genus *Somatogyrus*. A detailed anatomical description can be found in Thompson (1984b).

The distribution of *Birgella subglobosa* extends from Lake Champlain and its outlet, the Richelieu River, in New York, Vermont, and Quebec, west to Minnesota, and south to Arkansas, Alabama, and Georgia (Baker 1928a, Berry 1943, Clarke 1981, Thompson 1984b, Branson *et al.* 1987).

The only population found during this survey was in Lake Champlain, St. Lawrence River watershed (141C). Strayer (1987) did not find this species during a survey of the Hudson River drainage system. Buckley (1977) located one colony in the Black River, Jefferson County.

Lewis (1868, 1872) and Marshall (1894) reported the presence of *B. subglobosa* in the Hudson River basin, Mohawk, Herkimer County, and in the Erie Canal at Mohawk, into which it was believed introduced after 1860 to become "...numerically more abundant than any other mollusc in the canal" (Lewis 1872). It was also found in Onondaga County (Beauchamp 1886b) and as beach wash from Lake Ontario, Monroe County (Baker 1900b); the Niagara River, Niagara County (Letson 1909); Oneida Lake, Oswego County (Baker 1916a, b, 1918a, b); and the Hudson River from Hudson, Columbia County, to Hyde Park, Dutchess County (Townes 1936). Specimens deposited in Harvard's Museum of Comparative Zoology, the University of Michigan's Museum of Zoology, the Academy of Natural Sciences of Philadelphia, and the Florida State University Museum were collected from the Buffalo River; St. Albans Bay, Lake Champlain, Vermont; Hudson River, Coxsackie, Greene County; and Palmyra, Wayne County. Thompson (1984b) cites museum records from the Erie Canal and Mohawk River, Herkimer County, and from Schenectady County.

In some areas, this species is a deep water inhabitant of large lakes and rivers (Berry 1943, Clark 1981). However, in Lake Champlain (site 141C) it was found on a submerged tree trunk in shallow water. In the Hudson River it was found in mud and among aquatic plants in shallow water (Townes 1936) and on a soft silt substratum (Thompson 1984b).

Water chemistry values for the Lake Champlain site are: pH: 6.9, conductivity: 162 µmhos/cm, Ca^{++}: 13 ppm, and Na^{+}: 7 ppm.

Cincinnatia cincinnatiensis (Anthony, 1840)

Midland siltsnail
Fig. 9e

Shell globose-conical, 5.0-6.0 mm high, greenish to yellowish brown; umbilicus round, deep; spire broadly conical, elevated; nuclear whorl well-raised above second whorl; whorls 5.0-6.0, rounded, shouldered below suture, rapidly increasing in diameter; body whorl round; sutures deeply impressed; aperture roundly ovate, narrowed above, bluish-white within; peristome continuous; last whorl often separated from body whorl; basal part of columella thickened, upper part arched; verge bifid, with secondary lobe over six times size of penis, without accessory duct (Fig. 9e) (Baker 1928a, Berry 1943).

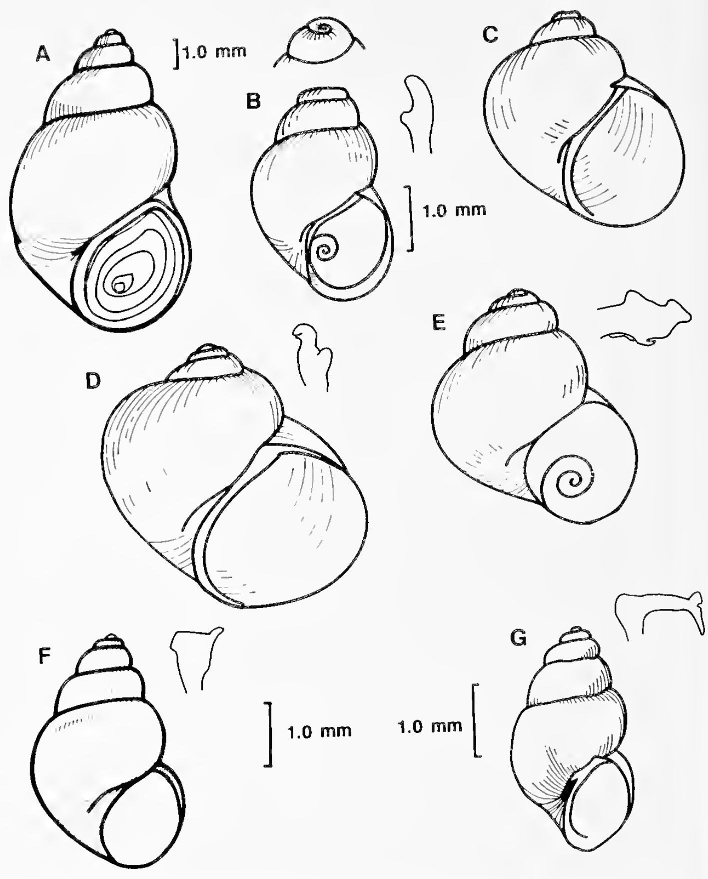


Fig. 9. a, Family Bithyniidae, shell: *Bithynia tentaculata.* b-g, Family Hydrobiidae, shells and penial structures: b, *Probythinella lacustris,* showing flattened apex; c, *Gillia altilis;* d, *Birgella subglobosa;* e, *Cincinnatia cincinnatiensis;* f, *Prygulopsis lustrica;* g, *P. letsoni.* Shell illustrations b-e are drawn to the same scale. Illustrations of penial structures are not to scale. Penial structures are redrawn from Berry (1943).

Cincinnatia integra (Say 1821) is here considered a synonym of *C. cincinnatiensis.*

This species ranges from New York and eastern Pennsylvania west to southern Manitoba, southern Saskatchewan, North Dakota and Utah, and south to Texas, Kansas, and Kentucky (Baker 1928a, Richards 1934, Berry 1943, Leonard 1959, Harman & Berg 1971, Clarke 1981, Cvancara 1983, Branson *et al.* 1987).

No populations were found during this survey. However, in the 1970s, *C. cincinnatiensis* populations were found in the Oswego River drainage system of New York State. Recently, a consulting firm found a population in the Buffalo River, Buffalo, Erie County, and submitted specimens to the author for identification (unpublished data). Specimens have been found in Seneca Lake, Seneca and Yates Counties; Otisco and Cross Lakes, Onondaga County; Oneida Lake, Onondaga and Cayuga Counties; and in the inlet of Canandaigua Lake, Yates County (Harman & Berg 1971). Shells, but no live animals, washed up in Canadara-

go Lake, Otsego County (Harman 1973). Additional populations were located in the Moose River, Lewis County; Kayuta Lake, Oneida County; inlet of Fifth Lake, Hamilton County, and two sites in Lewis County (Buckley 1977).

Earlier, this species was found in the Erie Canal, Onondaga County (Beauchamp 1886b), and in the Canal at Mohawk, Herkimer County (Lewis 1872, Marshall 1894). Other populations were found in Park Lake, Buffalo, Erie County (Letson 1909) and as beach wash from Lake Ontario, Monroe County (Baker 1900b); Sodus Bay, Lake Ontario, Wayne County; and the Salmon River, Oswego County (Burdick 1939). The New York State Museum has lots from the Erie Canal, Mohawk, Herkimer County (NYSM 31055), and from Ontario County (NYSM 31056).

Cincinnatia cincinnatiensis lives on muddy ooze or sand in slow creeks and lakes with little aquatic vegetation. Diatoms are their main food (Berry 1943). In North Dakota, populations are commonly associated with *Amnicola limosa*, and they inhabit large and small streams and permanent lakes and ponds (Cvancara 1983). Clarke (1979) found the species characteristic of mesotrophic lakes, and Harman & Berg (1971) noted it as a deep littoral resident of large lakes with silt and detritus substrata.

Harman & Berg (1971) reported habitat pH at 7.9-8.4.

Water chemistry data from North Dakota were pH: 7.9-9.2, conductivity 485-895 µmhos/cm, and Ca^{++}: 60-320 ppm (Cvancara 1983). *C. cincinnatiensis* might be limited to high calcium habitats, but additional data are needed to substantiate this possibility.

Pyrgulopsis lustrica (Pilsbry, 1890)

Boreal marstonia
Fig. 9f, 11

Shell conical, thin, 4.5 mm high, translucent, greenish to light brownish; umbilicus small, narrow; spire elevated, longer than aperture; apex elevated, acute; whorls 5.0, convex, regularly, but not rapidly, increasing is size, shouldered; sutures well-impressed; aperture roundly ovate, angled above, rounded below; interior waxy; peristome continuous, appressed to body whorl for short distance; columella moderately curved, verge with wide secondary lobe, without accessory duct (Baker 1928a, Berry 1943).

Some authors have placed this species in the genus *Marstonia*, and synonyms include *Marstonia decepta* (Baker 1928)

This species occurs from western Massachusetts, New York, Pennsylvania, and southern Ontario west to the Great Lakes states, and south to northern parts of the Mississippi River drainage (Baker 1928a, Berry 1943, Ludlam *et al.* 1973, Clarke 1981, Smith 1987, Strayer 1987).

During this survey, populations of *P. lustrica* were found in the Hudson River watershed (286, 287, 616); St. Lawrence River watershed (390, 498, 505, 517, 520); and Susquehanna River watershed (586). The species in not common, but it is regularly distributed across the southern half of the State.

Earlier studies noted that *P. lustrica* is widely scattered throughout central New York in larger rivers and Oneida Lake, Oswego River watershed; and in Canadarago Lake and Catatonk Creek, Susquehanna watershed (Harman & Berg 1971). It also has been found in Otsego Lake, Otsego County (MacNamara & Harman 1975); and Green Lake, Onondaga County (Harman 1970). Live populations were not found in the Finger Lakes, but shells were found in Skaneateles and Cayuga Lakes, Onondaga County (Harman & Berg 1971).

In the past, *P. lustrica* was reported from the Albany/Troy area, Albany and Rensselaer Counties (Marshall 1895); Irondequoit Bay, Lake Ontario, Monroe County (Baker 1900b); Cayuta Lake, Schuyler County (Maury 1916); Oneida Lake, Oswego County (Baker 1916a, b); and Chippewa Creek (Letson 1909). The Museum of Comparative Zoology has specimens from Seneca Lake, Yates County (MCZ 2108); Mohawk, Herkimer County (MCZ 53879); Schuyler Lake, Otsego County (MCZ 2107); Harlem River, New York City (MCZ 281981); Little Lakes, Herkimer County (uncatalogued); and the Normans Kill, Albany, Albany County (uncatalogued).

This study confirms Berry's (1943) report that *P. lustrica* is often associated with *Amnicola limosa*. Individuals live on rocks in rivers and lakes, and on vegetation, such as *Vallisneria, Potamogeton*, and *Chara* spp. (Berry 1943). In the Stockbridge Bowl, Massachusetts, the snails inhabit depths down to 4 m, but they are most abundant in the shallow littoral zone at 0-2 m (Ludlam *et al.* 1973). In contrast, populations living in Grand Traverse Bay, Michigan, on the eastern shore of Lake Michigan, were found in abundance on littoral silt and detritus in water 4-8 m deep. Highest densities, 165 snails/m^2, were in water 4 m deep (Pace *et al.* 1979). In central New York, this species tends to remain on inorganic substrata (Harman & Berg 1971). In association with *Valvata tricarinata* and *Goniobasis livescens* in lakes, it is found on stonewort (*Chara* sp.) on soft and hard marly substrata (Harman & Berg 1971, Smith 1987).

Nine sites for *P. lustrica* had the following water chemistry: pH: 6.6-8.0 (7.5 ± 0.1); conductivity: 208-419 µmhos/cm (329 ± 21); Ca^{++}: 5-49 ppm (27 ± 5); and Na^{+}: 7-28 ppm (116 ± 2). Harman & Berg (1971) reported pH values of 7.4-8.4. The snails appear to be inhabitants of medium to hard water, but they are tolerant of soft water ($Ca^{++} < 6$ ppm).

Pyrgulopsis letsoni (Walker, 1901)

Gravel pyrg
Fig. 9g

Shell elongate, solid, 3 mm high, dark corneous; umbilicus subimperforate or rimate; spire conical, longer than aperture; apex obtuse, blunt, dark corneous; whorls 4.5-6.0, somewhat flattened laterally, first 3 shouldered; sutures moderately impressed; aperture small, ovate, rounded below, angled above, flattened on parietal margin; peristome thick, continuous, entirely free of body whorl in adults; columella straight, oblique to axis; verge bilobed;

secondary lobe short, without accessory duct; penis long, black (Walker 1901, Baker 1928a, Berry 1943).

The range of this species is not well-documented. Extant populations seem to be limited to regions associated with Lake Erie, whereas Pleistocene fossil shells occur from western New York to Illinois (Berry 1943).

This species was not found during the present survey or that of Harman & Berg (1971).

Type specimens are from Pleistocene deposits from Goat Island, Niagara River, Niagara County (Letson 1909). Maury (1916) reported a population living in Chautauqua Lake, Chautauqua County. Townes (1937) also found this species in Chautauqua Lake, but he noted it as rare. It is possible that *P. letsoni* no longer lives in New York State.

These snails are difficult to collect alive. After intensive searching, Berry (1943) found them living in cavities in lime encrustations deposited by aquatic plants.

Amnicola (Amnicola) limosa (Say, 1817)

Mud amnicola
Fig. 10a, 11

Shell conical, somewhat inflated, 4-5 mm high, light yellow to tan; umbilicus narrow, deep; spire wide, obtusely conical; apex flat-topped; nuclear whorl small, on same plane as second whorl; whorls 4.5, inflated, regularly increasing in size; body whorl globose; sutures deeply impressed; aperture ovate, rounded below, slightly angled above; peristome continuous, joined to body whorl by thin callus; operculum paucispiral; verge wide, somewhat flattened, arising on right side of back beneath mantle lobe; secondary lobe short or erect, with accessory duct; penis sometimes coiling around erect secondary duct (Fig. 10a) (Baker 1928a, Berry 1943).

Berry (1943) includes *Amnicola porata* Gould as a synonym.

Amnicola limosa occurs from Newfoundland to Saskatchewan, south to Texas and South Carolina (Baker 1928a, Richards 1934, Rehder 1949, Tudorancea *et al.* 1979).

This species is one of the most abundant freshwater snails in New York State. It was found at 103 sites during this survey: Delaware River watershed (457, 458, 464, 466, 468); Housatonic River watershed (294); Hudson River watershed (212, 265, 269, 271, 273, 276, 277, 284, 286, 287, 291, 292, 297, 299, 301, 303, 305, 317, 318, 319, 320, 321, 367, 381, 384, 386, 453, 599, 601, 604, 607, 610, 612, 613, 616); Mississippi-Ohio River watershed (427b, 430A, 430B, 431); St. Lawrence River watershed (141D, 259A, 262, 263, 278, 308, 311, 312, 336, 338, 340, 341, 345, 352, 353, 354, 357, 358, 360, 361, 363, 374, 377, 390, 408, 440, 448A, 448B, 449, 493, 495, 497, 498, 499, 500, 501, 502A, 502B, 505, 515, 517, 518, 520, 521, 524, 527, 529, 534, 535, 562, 563); and Susquehanna River watershed (400, 542, 571, 573, 582, 586, 592).

There are numerous publications referring to the presence of *A. limosa* in New York State. It has been found in the Erie Canal, Herkimer and Monroe Counties (Lewis 1860, 1872; Marshall 1894); the Finger Lakes (De Kay 1843, Lewis 1874, Beauchamp 1886b, Harman & Berg 1971); Chautauqua Lake and others in Chautauqua and surrounding counties (Maury 1898, 1916; Townes 1937); Niagara and Erie Counties (Walton 1891, Letson 1909); Livingston County (Walton 1891, 1898; Wade & Vasey 1976; Wade 1987); Oneida Lake, Oswego and Onondaga Counties (Baker 1916a, b, 1918a, b; Pratt 1923); Lake Ontario (Baker 1900b, Burdick 1939); the Hudson River drainage, Rockland County (Bretet & Carswell 1952); Albany and Troy, Albany and Rensselaer Counties (Marshall 1895); the Shawangunk Kill and Wallkill River, Ulster County (Strayer 1987); Lake Champlain (Lewis 1894, Harman 1973, MacNamara & Harman 1975); and the Adirondack region (Jacobson 1945, Buckley 1977).

Habitats of *A. limosa* include lakes, permanent ponds, and slowly flowing rivers and streams. The snails prefer decaying aquatic and terrestrial plants, logs, branches, rocks, bottles, and empty clam shells as substrata. They are frequently associated with aquatic vegetation, such as *Chara*, *Potamogeton*, *Vallisneria*, and *Elodea* spp., upon which they graze for algae, such as epiphytic diatoms (Berry 1943, Harman & Berg 1971, Harman 1972, Kesler 1981, Jokinen 1983, Smith 1987, Strayer 1987). During this survey in New York State, populations were found in 25 river and stream sites, 52 lake sites, 15 permanent ponds, five marshes, five canals, and a swamp.

This species has an annual life cycle. Oviposition begins in shallow water from late May to June, when the water warms to 22-23°C. Single eggs are laid on various substrata. Juveniles appear from late June to early August. A few mature snails continue to grow after reproduction, but most die as the juveniles grow. In autumn, the new generation migrates into deeper water, aggregates, and spends the winter in a dormant state. In early spring, when the water is approximately 10°C, the young migrate back to shallow water and grow rapidly prior to ovipositing (Pinel-Alloul & Magnin 1973, Horst & Costa 1975, Tudorancea *et al.* 1979, Kesler 1980, Jokinen 1985). *A. limosa* populations can dominate the benthos, and this species can be a major contributor to the energy budget (Tudorancea *et al.* 1979).

Ninety-six survey sites had the following water chemistry data: pH: 5.8-9.2 (7.2 ± 0.1); conductivity: 28-2320 µmhos/cm (258 ± 28); Ca^{++}: 1-89 ppm (17 ± 2); and Na^{+}: 1-291 ppm (19 ± 4). For North Dakota, Cvancara (1983) reported the following water chemistry values: pH: 8.5-9.2; conductivity: 485-760 µmhos/cm; and Ca^{++}: 110-130 ppm. *A. limosa* also was abundant in Connecticut's soft water: pH: 5.8-7.8; conductivity: 43-386 µmhos/cm; Ca^{++}: 2-35 ppm; and Na^{+}: 1-29 ppm (Jokinen 1983). This species appears to have a wide range of tolerance for pH and cations, and it is able to live in soft to hard waters. However, it is probably most successful in medium and medium-soft waters (McKillop & Harrison 1972). This survey and

Baily's (1929) study show the snail also has a high sodium tolerance and can be found in tidal areas of coastal waters.

Amnicola (Lyogyrus) walkeri Pilsbry, 1898

Canadian duskysnail
Fig. 10b

Shell conical, thin, 2.5 mm high, almost as wide as high, translucent, yellowish, corneous; umbilicus wide, deep; spire broadly conical; apex obtuse; nuclear whorl elevated above second whorl; whorls 4.0, convex, shouldered, increasing regularly and rapidly in size; sutures deeply impressed; aperture almost circular, slightly angled above; peristome continuous, contacting body whorl for short distance; operculum paucispiral; verge bifid, penis and secondary lobe arising together, with accessory duct; penis never coiling around secondary lobe (Baker 1928a, Berry 1943).

This species occurs from central New York State west to Wisconsin and south to the upper Mississippi River basin (Baker 1928a, Berry 1943, Harman & Berg 1971, Clarke 1981). It possibly reaches to the District of Columbia (Richards 1934).

No specimens of *L. walkeri* were taken during this survey. Harman & Berg (1971) found three populations, two from the western Otsego drainage and one from the Genesee River watershed.

Older records from scattered areas in the State document the presence of *A. walkeri*, then known as *Amnicola lustrica* Say. The earliest record is from De Kay (1843), who reported populations from Cayuga Lake, Cayuga, Seneca and Tompkins Counties, and from streams entering Lake Champlain, Clinton County. Lewis (1860, 1872) noted this species living in the Erie Canal; Mohawk River; Little Lakes and Smith's Pond, Herkimer County; and in Schuyler Lake, Otsego County. Additional early records are from Chautauqua Lake, Chautauqua County (Maury 1898, Baker 1928b); Onondaga County (Beauchamp 1886b); Niagara River, Niagara County (Letson 1909); Upper Cassadaga Lake, Canandaigua County (Townes 1936); Sodus Bay, Wayne County; and Little Sodus Bay, Cayuga County; Lake Ontario; and South Pond, Oswego County (Burdick 1939). The Museum of Comparative Zoology has a lot collected by E. Letson from Lime Lake, Cattaraugus County (MCZ 183481).

No living snails were found during this survey.

This species lives in sluggish streams and quiet ponds where dead aquatic plants have accumulated (Berry 1943, Clarke 1981). Populations occur in a range of lentic habitats, including oligotrophic lakes and marl ponds (Harman & Berg 1971).

Amnicola (Lyogyrus) pupoidea (Gould, 1841)

Pupa duskysnail
Figs. 10c, 11

Shell narrowly conical, 3 mm high; whorls attenuated; adult peristome continuous, not attached to or barely touching body whorl; operculum multispiral in center, paucispiral peripherally; verge bifid, lobes at acute angles to main trunk of verge; secondary lobe with accessory duct (Berry 1943, Thompson 1968, Jokinen 1983).

This species is generally distributed along the Atlantic coast from Massachusetts, Connecticut, and New York south to the District of Columbia, Louisiana, and Arkansas (Richards 1934, Jokinen 1983, Smith 1987). The precise distribution is unknown.

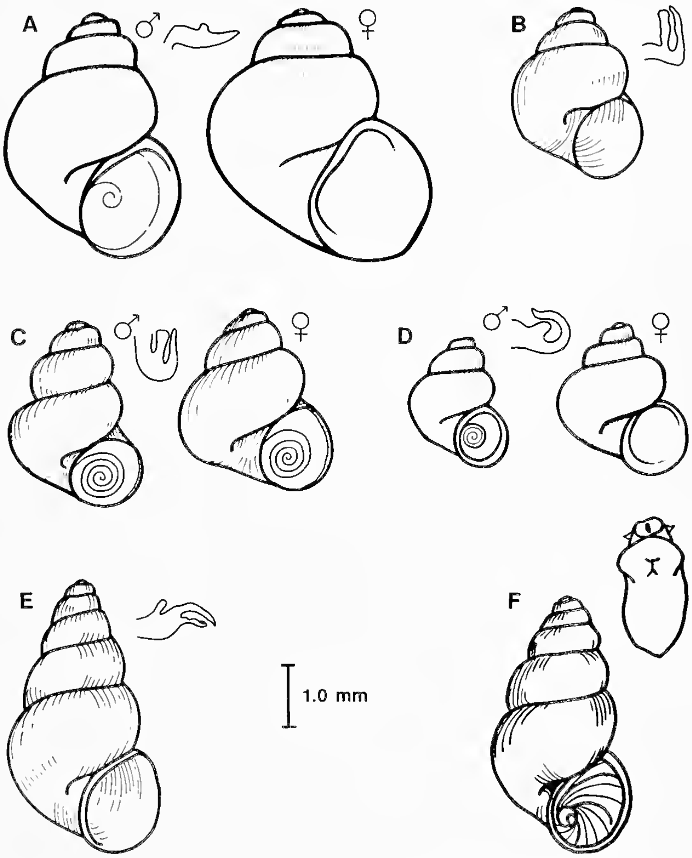


Fig. 10. a-e, Family Hydrobiidae, shells and penial structures: a, *Amnicola limosa*, male and female; b, *A. walkeri*, c, *A. (Lyogyrus) pupoidea*, male and female, operculum with multispiral center and paucispiral periphery; d, *A. (Lyogyrus) grana*, male and female; e, *Fontigens nickliniana*; f, Family Pomatiopsidae, shell and ventral view of foot showing mid-lateral indentations: *Pomatiopsis lapidaria*. Penial structures from Berry (1943) and Thompson (1968).

Sixteen colonies of *A. pupoidea* were located during this survey, all in eastern New York State: Delaware River watershed (457, 475); Hudson River drainage (286, 300, 301, 305, 317, 318, 320, 612); St. Lawrence River watershed (313, 336); Susquehanna River basin (568, 571, 573); and the Hackensack River system (606).

Bretet and Carswell (1952) found *A. pupoidea* in Upper Ferdun Pond, Rockland County. Harman & Berg (1971) found no colonies in central New York. Strayer (1987) located two populations in the Hudson River, Dutchess County, just below high tide mark.

During this survey it was found that *A. pupoidea* lives in small to large ponds and large rivers on organic debris and aquatic plants, confirming the work of Jokinen (1983) and Smith (1987).

The life cycle is annual, and there appears to be sexual dimorphism, with males being relatively longer and more slender than females (Jokinen, unpublished data).

Water chemistry data for 16 sites were: pH: 6.1-9.5 (7.4 ± 0.2); conductivity: 68-335 μmhos/cm (173 ± 20); Ca^{++}: 1-37 ppm (15 ± 3); and Na^{+}: 1-35 ppm (9 ± 2). For Connecticut, the values for 14 sites were similar: pH: 5.5-7.8; conductivity: 53-275 μmhos; Ca^{++}: 2-27 ppm; and Na^{+}: 5-31 ppm (Jokinen 1983). *A. pupoidea* has high tolerance for acidic, low calcium habitats. However, it does not appear to be tolerant of high sodium.

Amnicola (Lyogyrus) grana (Say, 1822)

Squat duskysnail
Figs. 10d, 11

Shell broadly conical, 3 mm high; umbilicus small; apex dome shaped; sutures deep; peristome adhering to body whorl; aperture orbicular; operculum multispiral in center, paucispiral at periphery; verge bifid; penis looped over secondary lobe (Thompson 1968, Jokinen 1983).

This species occurs on the east coast of North America east of the Appalachians and Alleghenies from New England south to North Carolina (Richards 1934, Jokinen 1983, Smith 1987).

In New York State, *A. grana* occurs in the Hudson River watershed (287, 304, 459, 602, 604, 610); Mississippi-Ohio River watershed (430A, 431); and St. Lawrence River watershed (259A, 339, 408).

In the 19th century, *A. grana* was reported from the Seneca River, Onondaga County (Beauchamp 1886b); Monroe County (Walton 1891); and Chautauqua Lake, Chautauqua County (Maury 1898). More recent publications do not report this species from New York State.

Individuals live on organic debris and vegetation in the standing water of larger ponds, lakes, and oxbows of major rivers (Clarke 1981, Jokinen 1983, Smith 1987).

Nine sites had water chemistry values of: pH: 6.6-8.2 (7.3 ± 0.2); conductivity: 189-452 μmhos/cm (287 ± 29); Ca^{++}: 3-49 ppm (21 ± 5); and Na^{+}: 1-39 ppm (15 ± 4). Connecticut values for 14 sites (Jokinen 1983) were more acidic: pH: 5.4-7.8; conductivity: 39-241 μmhos/cm; Ca^{++}: 1-27 ppm; and Na^{+}: 2-19 ppm. This species has a high tolerance for acidic, low calcium habitats but limited tolerance to sodium.

Fontigens nickliniana (Lea, 1838)

Watercress snail
Fig. 10e

Shell elongate oval, 4.5 mm high, turreted, twice as high as wide, greenish-tan or white under a black organic coating; umbilicus subimperforate or absent; apex blunt; nuclear whorl partly concealed by second whorl; whorls 5.3, highly convex; sutures deep; aperture roundly ovate; peristome continuous, appressed to parietal wall for a considerable distance; operculum paucispiral; verge trifid, with 2 secondary lobes and 2 accessory ducts present; penis to right of lobes (Baker 1928a, Berry 1943).

This species was once considered a member of the genus *Hydrobia*.

Populations of *F. nickliniana* occur from Niagara Falls, New York, west to Wisconsin and south to Alabama (Baker 1928a, Berry 1943).

Populations of this species were not found in New York State during this survey, and Harman and Berg (1971) did not report finding the species in central New York. If present in the State, it might be limited to the western region.

Lewis (1872) reported the species as present in the Erie Canal at Mohawk, Herkimer County. Maury (1898) reported living populations to be present, but rare, in Chautauqua Lake, Chautauqua County. The Museum of Comparative Zoology has specimens from Niagara Falls, Niagara County (MCZ 186762).

This species resides in cool, shallow, slowly flowing springs where watercress (*Nasturtium officinale* R. Br.) grows in a thick mat (Goodrich 1932, Berry 1943).

Family Pomatiopsidae

Shell elongate, turreted, thin to thick, smooth, umbilicate; aperture expanded; peristome continuous, thin or slightly reflected; operculum corneous, subspiral with spiral sculpture; foot broad, truncated anteriorly, rounded posteriorly, with transverse sulcus between front and middle third of foot; species dioecious; verge simple, large (Baker 1928a).

Pomatiopsis lapidaria (Say, 1817)

Slender walker
Fig. 10f, 13

Shell up to 7 mm long, dark brown to chestnut; spire acute, 3 times as long as aperture, nuclear whorl partly embraced by second whorl; umbilicus well-marked; whorls 7.0, rounded, slowly and regularly increasing in diameter; sutures well-impressed; aperture elongate oval, narrowed and angled above, rounded below, somewhat purple within; peristome simple or thickened within, upper termi-

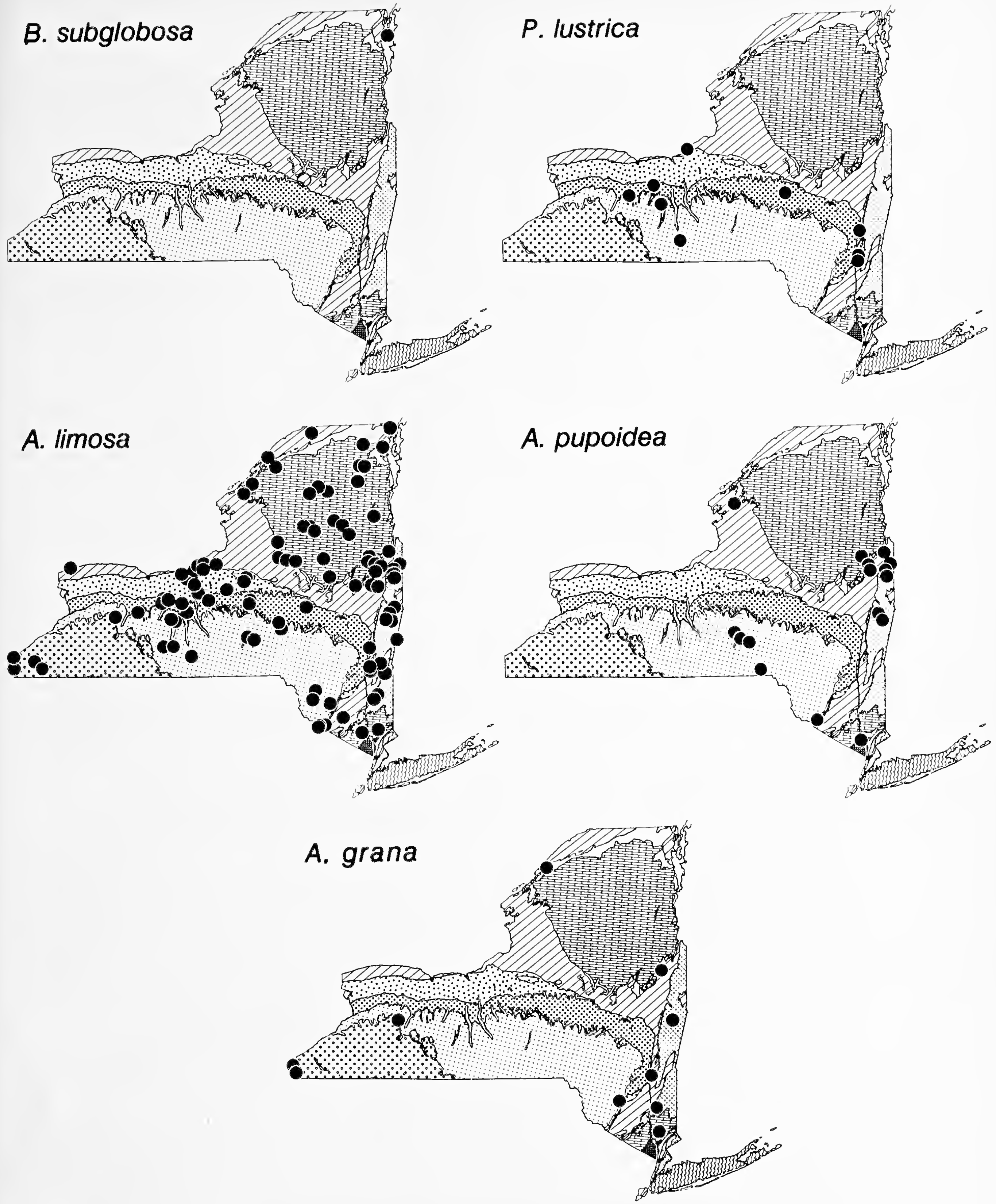


Fig. 11. Known distributions of species of Hydrobiidae in New York State.

nation connected on parietal wall by callus; tentacles short, tapering; verge large, sickle-shaped, posterior to right tentacle at right side of neck, not exposed beyond shell edge (Baker 1928a); *populations dimorphic, males with higher whorl count and more slender shell than females* (Dundee 1957).

Detailed anatomical descriptions can be found in works by Dundee (1957) and Davis (1967).

This species is widespread in eastern North America. It occurs from Minnesota to southern Ontario, south to Florida and Texas (Baker 1928a; Richards 1934; Berry 1943; Abbott 1948; Dundee 1957; Leonard 1959; Hubricht 1960; Clarke 1981; Thompson 1984a; Smith 1986, 1987; Branson *et al.* 1987; Burch 1989; Jokinen, unpublished data). It is rare in southern New England, and it is considered endangered in Massachusetts (Smith 1987; Jokinen, unpublished data).

Only one living population of *P. lapidaria* was found during this survey. It was located at Saw Kill stream and millpond (site 287), Annandale-on-Hudson, Hudson River watershed, Dutchess County. In addition, one shell was retrieved from marl from the Cayuga and Seneca Canal (site 534), Tyre, St. Lawrence River watershed, Seneca County, but no live population was found. Neither Strayer (1987) nor Harman & Berg (1971) located populations.

Several museum records indicate the existence of other populations of *P. lapidaria*, but even these are not abundant: Niagara Falls, Niagara County (1926, MCZ 282047; 1935, MCZ uncatalogued; 1951, MCZ 186760); Upper Red Hook, Dutchess County (1889, Teator Collection, MCZ 156830); South Bay at Saw Kill mouth, under rock in upper intertidal, Dutchess Co. (1971, Bard College collection); Hudson River, Greenbush, Rensselaer County (Beecher Collection, NYSM 31113).

Literature reports on *P. lapidaria* in New York also are sparse. The species has been reported from Monroe County (Walton 1891, 1898); the Erie Canal at Mohawk, Herkimer County (Marshall 1894); Niagara Falls, Niagara County (Letson 1909); the Normans Kill, Albany County; Troy and Greenbush, Rensselaer County (Marshall 1895); and the Hudson River at Hudson, Columbia County (Townes 1936). A distribution map in Dundee (1957) indicates several sites on the lower Hudson and Niagara Rivers.

This species is more amphibious than aquatic and is able to exist 150 m from a body of water (Berry 1943). Populations usually live on the moist soils of river banks, on marsh detritus, and on the lower stems of river bulrush (*Scirpus fluviatilis* (Torr.) Gray), often close to sensitive fern (*Onoclea sensibilis* L.) (Smith 1987, Thompson 1984a, Dundee 1957.)

In Michigan, *P. lapidaria* has a life span of three years, and populations have over two females for every male. The species has two major reproductive periods per year, the first from March to early July and a second from late August to early October. Eggs are laid singly on soil, and they are coated with a husk of soil and fecal pellets. At 15.6-18.3°C, incubation takes five to seven weeks. Newly hatched young, 0.5 mm in shell length and with 2.5 whorls, grow approximately 0.2 mm per week (Dundee 1957).

In Michigan, this species has two dormant periods, one in winter and one during summer drought. The snails, with their apertures closed by opercula, remain inactive under fallen vegetation or other objects, or in crevices (Dundee 1957).

Hubricht (1960) reports *P. lapidaria* to be calciphilic. The New York population in the Saw Kill (site 287) lived associated with hard water, pH: 7.6, conductivity: 335 µmhos/cm, Ca^{++}: 49 ppm, and Na^{+}: 10 ppm.

Family Pleuroceridae

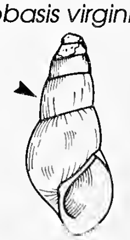
Shell elongate to globose, thick, solid, without umbilicus; operculum corneous, subspiral; tentacles elongate; genital duct of 2 laminae forming closed canal; oviparous, lacking external verge (Baker 1928a).

Key to the Pleuroceridae (based on adult characters)

1a. Aperture and spire approximately same length, shell conic .... *Leptoxis carinata*

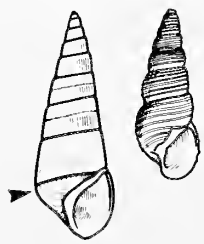
1b. Spire considerably longer than aperture 2

2a. Whorls rounded, sometimes with spiral ridges .... *Goniobasis virginica*



2b. Whorls flattened, without spiral ridges 4

3a. Body whorl with distinct angulation .... *Pleurocera acuta*



3b. Body whorl without distinct angulation ....*Goniobasis livescens*

Pleurocera acuta Rafinesque, 1831

Sharp hornsnail
Figs. 12a, 13

Shell elongate, over 30 mm long, acute, turreted, of variable thickness; apex usually eroded; pale brown to chestnut to black, sometimes with yellow band encircling whorls just below suture; nuclear whorls wine colored; whorls up to 15.0, flat sided, regularly increasing in diameter; upper 7-11 whorls double-carinate just above suture; body whorl distinctly angulate with sharply defined carina, sometimes 1-2 small carinae encircling; aperture narrowed above, white, pale blue or purple within, produced and canaliculate below, near columella; peristome acute, smooth, thick; columella pale blue, twisted; terminations of peristome and columella joined by thick, somewhat spreading callus; operculum paucispiral, chitinous, thin, red-brown (Baker 1928a, Dazo 1965).

A detailed account of the anatomy of this species can be found in Dazo (1965).

Pleurocera acuta occurs from Quebec, Vermont, and northeastern New York, west to Kansas, Nebraska, and Minnesota, and south to Louisiana and the Mississippi drainage basin (Goodrich 1939a, b; Leonard 1959; Dazo 1965).

During this survey, populations were located at five New York sites, one in the Mississippi-Ohio River watershed (431) and four in the St. Lawrence River watershed (141C, 340, 531, 562).

The first report of this species occurring in New York was De Kay's (1843). The specimens came from Lake Erie. Lewis (1856b, 1860, 1874) reported *P. acuta* in Herkimer and Otsego Counties; from the Niagara River, Niagara County; and Mohawk, Herkimer County. In the late 19th and early 20th centuries, populations existed in the Erie Canal, Onondaga County (Beauchamp 1886b); Erie Canal (Walton 1891, 1898); Lake Ontario, (Marshall 1894); Irondequoit Bay in Lake Ontario; and the Erie Canal "Wide Waters", Rochester, Monroe County (Baker 1900b). Other sites include the Niagara River, Niagara County (Letson 1909), and Cayuga Lake, Cayuga and Seneca Counties (Maury 1916).

In the 1930s and 1940s additional populations were reported existing in Sodus Bay, Lake Ontario, Wayne County (Burdick 1939); the Hudson River, Hudson, Columbia County (Townes 1936); and in the vicinity of Mohawk, Herkimer County (Goodrich 1942). More recently, specimens of this species have been found in Conesus Lake, Livingston County (Wade & Vasey 1976, Wade 1987), the Mohawk River at Cohoes, Albany County; and the Hudson River at Troy, Rensselaer County (Smith 1983). It is believed that *P. acuta* reached the Hudson basin via the Erie Canal (Goodrich 1942, Smith 1983, Strayer 1987).

This species can be found in a variety of habitats. In lakes, the snails live on boulders on exposed shores or in mud and sand. In rivers, they are usually on stones in a rapid current (Baker 1928a, Goodrich 1932). The snails tend to remain in shallow water up to 1 m deep, where they burrow under the sand and layers of decaying leaves and other organic matter (Dazo 1965). The five sites located during this survey included two rivers, two lakes, and a canal.

Research on the natural history of *P. acuta* was conducted in Michigan by Dazo (1965). The snails oviposit in April, as soon as they become active. The reproductive period peaks in April and May, and it does not extend into June. Eggs, deposited in masses of 1-19, are encased in clear, spherical compartments and are surrounded by a transparent, gelatinous matrix. Parent snails coat the upper sides of the masses with fine sand. Individuals lay 15 eggs/day. Females oviposit for the first time at two years of age, when their average shell length is 17 mm, the average number of eggs/mass being 2.8. At three years, the number of eggs/mass increases to 6.6. The young begin to hatch after two weeks. In both laboratory and field populations, females are more abundant than males. The female to male ratio was 2.1:1.0 in the laboratory and 3.0:1.0 in the field. Densities vary from 12-42 snails/m^2. Individuals slowly plow through sandy substrata with rostrum fully extended. In the laboratory, they migrated to aquarium bottoms at night and remained buried in sand until morning. Stomach contents indicate the diet of *P. acuta* to be primarily green and red algae, diatoms, and desmids. They also ingest decaying vegetation and fine sand grains.

Four New York sites had the following water chemistry values: pH: 6.9-8.4 (7.5 ± 0.4), conductivity: 162-600 µmhos/cm (352 ± 92), Ca^{++}: 7-26 ppm (18 ± 5), and Na^{+}: 7-92 ppm (35 ± 19). Field sites in Michigan had pH values of 7.5-8.6 and high oxygen concentrations (Dazo 1965). It appears that this species prefers moderate to hard waters and has a high sodium tolerance.

Goniobasis livescens (Menke, 1830)

Liver elimia
Fig. 12b, 13

Shell to 20 mm long, highly variable, elongate to ovate-acuminate, pale blue or tan to green and brown, often with 2 dark bands; frequently turreted on upper whorls; apex brown or wine colored; whorls 12.0, somewhat rounded, carina encircling center of spire whorls, obsolete

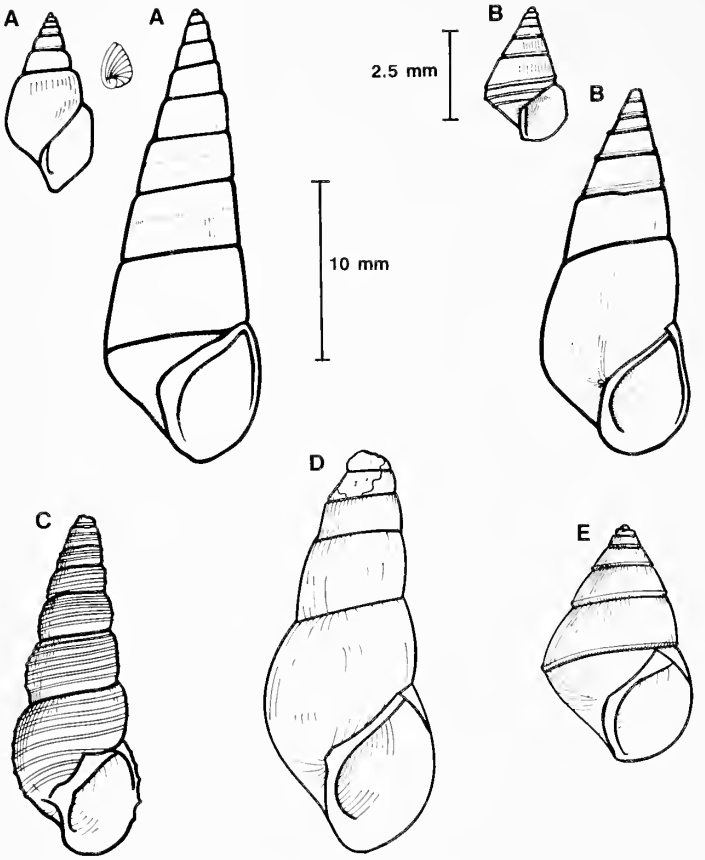


Fig. 12. Family Pleuroceridae, shells: a, *Pleurocera acuta,* with immature individual shown to the upper left; b, *Goniobasis livescens,* with immature individual shown to the upper left; c, *G. virginica,* ridged form; d, *G. virginica,* smooth form; e, *Leptoxis carinata.* All illustrations of adults are drawn to the same scale.

on last 2 whorls; sutures well-impressed; spire sharply conical, last whorl somewhat bulbous; aperture large, purple within; peristome sharp, edge thin, thickened by callosity within outer lip; columella thick, solid, tinged blue or purple, reflected over columellar region and lip (Baker 1928a, Goodrich 1932, 1939b).

Burch (1989) places this species in the genus *Elimia.*

Anatomical details can be found in Dazo (1965).

The distribution of this species ranges from Quebec and Lake Champlain west to the Great Lakes region (except Lake Superior), and south to the Mississippi drainage in Iowa, Illinois, Indiana, and Ohio. The species moved into the Hudson River drainage via the Erie Canal (Baker 1928a, Berry 1943, Goodrich 1945, Dazo 1965, Clarke 1981).

All New York State sites located during this survey are in the St. Lawrence River watershed (344, 404, 437, 494, 499, 504, 505, 513, 514, 515, 518A, 518B, 521, 527, 529, 530, 535).

Goniobasis livescens was first reported in New York State in the 1870s from the Niagara River, Niagara County; and the Erie Canal and Mohawk River, Herkimer County (Lewis 1872, 1874). Soon after, the snails were found in the Mohawk River, Cohoes, Albany County; the Albany/Troy region in Albany and Rensselaer Counties (Marshall 1895); Onondaga County (Beauchamp 1886b); and the Erie Canal, Monroe County (Walton 1891). At the turn of the century, populations were reported from the Genesee River, Monroe County (Baker 1901); and Eighteen Mile Creek and the Niagara River, Niagara County (Letson 1909). By the 1910s, snail populations inhabited Oneida Lake, Oswego and Onondaga Counties (Baker, 1916a, b, 1918a, b; Pratt 1923). However, by 1968 Harman (1968a) could not find this species in that lake. Additional populations were noted in the Erie Canal "Widewaters," Rochester, and the Genesee River, both in Monroe County (Baker 1900b). Townes (1936) reported the species from the Hudson River from North Germantown, Columbia County, to Rhinecliff, Dutchess County. Burdick (1939) collected *G. livescens* from Lake Ontario at Sodus Bay and Port Bay, Wayne County, and from Little Sodus Bay, Cayuga County. More recently, this species has been found in Green Lake in the Oswego River watershed, Onondaga County (Harman 1970); Owasco Lake and Cayuga Lake, Cayuga County; Seneca Lake, Seneca and Yates Counties; Keuka Lake, Steuben County; DeRuyter Lake, Madison County (Harman & Berg 1971); Conesus Lake, Livingston County (Wade & Vasey 1976); Mohawk River at Cohoes, Albany County; and in the Hudson River at Troy, Rensselaer County (Smith 1983).

G. livescens grazes in shallow water on stones and gravel in lakes and clear, rapid streams (Baker 1928a). On rocky substrata in rivers, the snails cling to sides of algae-covered stones, whereas in lake situations they burrow into sand or move among aquatic plants. Densities vary from 11-892 snails/m^2 (Dazo 1965). During winter, with their apertures tightly closed, they survive under the ice, hidden under stones or layers of decaying matter (Goodrich 1945, Dazo 1965). The New York sites located during this survey include five river and stream sites, eight lake sites, two permanent ponds, and two canals.

Individuals mate in autumn, hold sperm through the winter, and begin to oviposit in April as soon as they become active. Egg-laying peaks in April and May and continues until August (Dazo 1965). Eggs, uncovered except for a shell membrane, appear singly or in rows. Unlike *Pleurocera acuta, G. livescens* eggs lack a sand cover, but they do have a thin coating of soil which blends in with the substratum (Dazo 1965).

In the laboratory, young adults lay an average of 2.8 eggs/clutch, but in the field they lay 4.7 eggs/clutch. Older snails deposit 6.6 eggs/clutch in the laboratory and 9 eggs/clutch in the field. Over a period of 20 days, females can deposit an average of 3,264 eggs. The young begin to hatch two to three weeks after oviposition and live for approximately three years. Females outnumber males 6.5:1.0 in the field and 2.4:1.0 in the laboratory (Dazo 1965).

Individuals of *G. livescens* move over rocks and stones, scraping off green and red algae, diatoms, desmids, and bacteria for food (Dazo 1965). It has been hypothesized that the radula is best suited for obtaining large food particles, such as detritus, from sand. Compared to the pulmonates, this species is an inefficient alga grazer (Barnese & Lowe 1990).

At night in the laboratory, the snails, with their heads withdrawn, remain on the bottom of the aquarium on sand and gravel. In the morning, they crawl up the sides of the aquarium (Dazo 1965).

Water chemistry values for 16 of the collecting sites for *G. livescens* in New York are: pH: 7.3-8.5 (7.7 ± 0.1), conductivity: 178-820 µmhos/cm (342 ± 46), Ca^{++}: 9-40 ppm (23 ± 2), and Na^{+}: 6-125 ppm (26 ± 8). Harman & Berg (1971) documented pH values of 7.3-8.5 (mean = 7.9). Dazo (1965) noted that under experimental conditions, snails survived only at pH values 8.0-8.4 (Dazo 1965).

Goniobasis virginica (Say, 1817)

Piedmont elimia
Figs. 12c, d; 13

Shell elevated, thickened, yellow to yellow-green to fawn to chestnut, with two chestnut spiral stripes in medial and basal positions; nuclear whorls blue, chestnut, or white; whorls up to 12.0, usually 6-9, body and penultimate whorls shouldered, often with spiral carinae, turreted; sutures deep; aperture weakly angulate, lacrimate; peristome sharp, outer lip sinuous; columella smooth, imperforate, with suffusion of white callus at base (Harman & Berg 1971).

Burch (1989) places this species in the genus *Elimia*.

C. virginica is limited to the eastern Atlantic coastal states from Virginia to Connecticut (Richards 1934, Goodrich 1942, Jokinen 1983, Gerberich 1981, Smith 1987), including New York (Harman & Berg 1971, Strayer 1987).

Six populations of *G. virginica* were found during this study. The sites were in the Hudson River watershed (96A, 96B), Mississippi-Ohio River watershed (431), and the St. Lawrence River watershed (404, 531, 534).

Records of this species from Mud Creek, Onondaga County, can be traced back to De Kay (1843). Sometime between 1856 and 1869 the species was introduced into the Erie Canal, Mohawk, Herkimer County (Lewis 1860, 1868, 1872). Lewis (1872) reported that *G. virginica* also inhabited streams near Buffalo, Erie County. Other populations occurred in the Erie Canal and Seneca River, Onondaga County (Beauchamp 1886b); the Erie Canal between Ilion, Herkimer County and Utica, Oneida County (Bailey 1891); Irondequoit Bay, Lake Ontario, Monroe Country (Walton 1891, 1898; Baker 1900b); the Hudson River at Albany, Albany County; Normans Kill, Albany County; and the Erie Canal, Monroe County (Marshall 1894). By 1916, populations were found in Cayuga Lake, Seneca and Cayuga Counties; and in Conesus Lake, Livingston County (Maury 1916). By the 1940s, however, Conesus Lake apparently no longer harbored the snail (Robertson & Blakeslee 1948). Townes (1936) reported the species in the Hudson River from Hudson, Columbia County, to Rhinecliff, Dutchess County, and Burdick (1939) described a population at the mouth of the Salmon River at Lake Ontario, Oswego County. Harman & Berg (1971) found only shells in the Oswego River watershed, but they located live populations in the Susquehanna drainage.

Individuals live on stones in the shallows of large rivers (Townes 1936, Jokinen 1983, Smith 1980). In deep water, they are found on all substrata, including vegetation. Populations living in lakes are found on silt-covered substrata of cobbles, gravel, sand, and clay (Harman & Berg 1971). Populations located during this survey were at four river and two canal sites.

In Maryland, *G. virginica* lays its eggs in June. They are spirally arranged in masses of 2-15 or more. They have a tough, outer, membranous covering, and septa divide the mass into compartments. Foreign matter is attached to the egg masses (Winsor 1933). It appears that little else is known about the natural history of this species.

At the three sites where data were taken, water chemistry values were: pH: 7.8, 8.0, 8.4, conductivity: 401, 600, 602 µmhos/cm, Ca^{++}: 26, 26, 32 ppm, and Na^{+}: 20, 88, 92 ppm. Harman & Berg (1971) reported pH values of 7.9-8.3 for four sites in the Susquehanna River watershed. The species tolerates up to 50% salinity (Baily 1929).

Leptoxis carinata (Bruguière, 1792)

Crested mudalia
Figs. 12e, 13

Shell up to 20 mm, globose to elevated, turreted or carinate, amber or olive to chestnut, sometimes with 2-3 chestnut spiral stripes on body and penultimate whorls; umbilicus imperforate; whorls 6.0-7.0, strong carina on center of whorls, sometimes disappearing on body whorl; sutures shallow; aperture thickened, not reflected, broadly lacrimate; outer lip of peristome straight, with wine or light blue callus; columella straight, smooth, wine or chestnut; operculum paucispiral, chitinous, fragile (Harman & Berg 1971).

Leptoxis carinata occurs on the Atlantic Coastal Plain, from New York south to North Carolina (Richards 1934, Goodrich 1942).

No specimens were collected during this survey. Harman and Berg (1971) found the species in tributaries of the Susquehanna River watershed. The New York State Museum has 11 lots collected between 1955 and 1966 in Broome, Chenango, Cortland, Otsego, Steuben, and Tioga Counties (NYSM 2235-2245).

Early literature records indicate that this snail inhabited Lake Champlain, Clinton County (De Kay 1843); Homer,

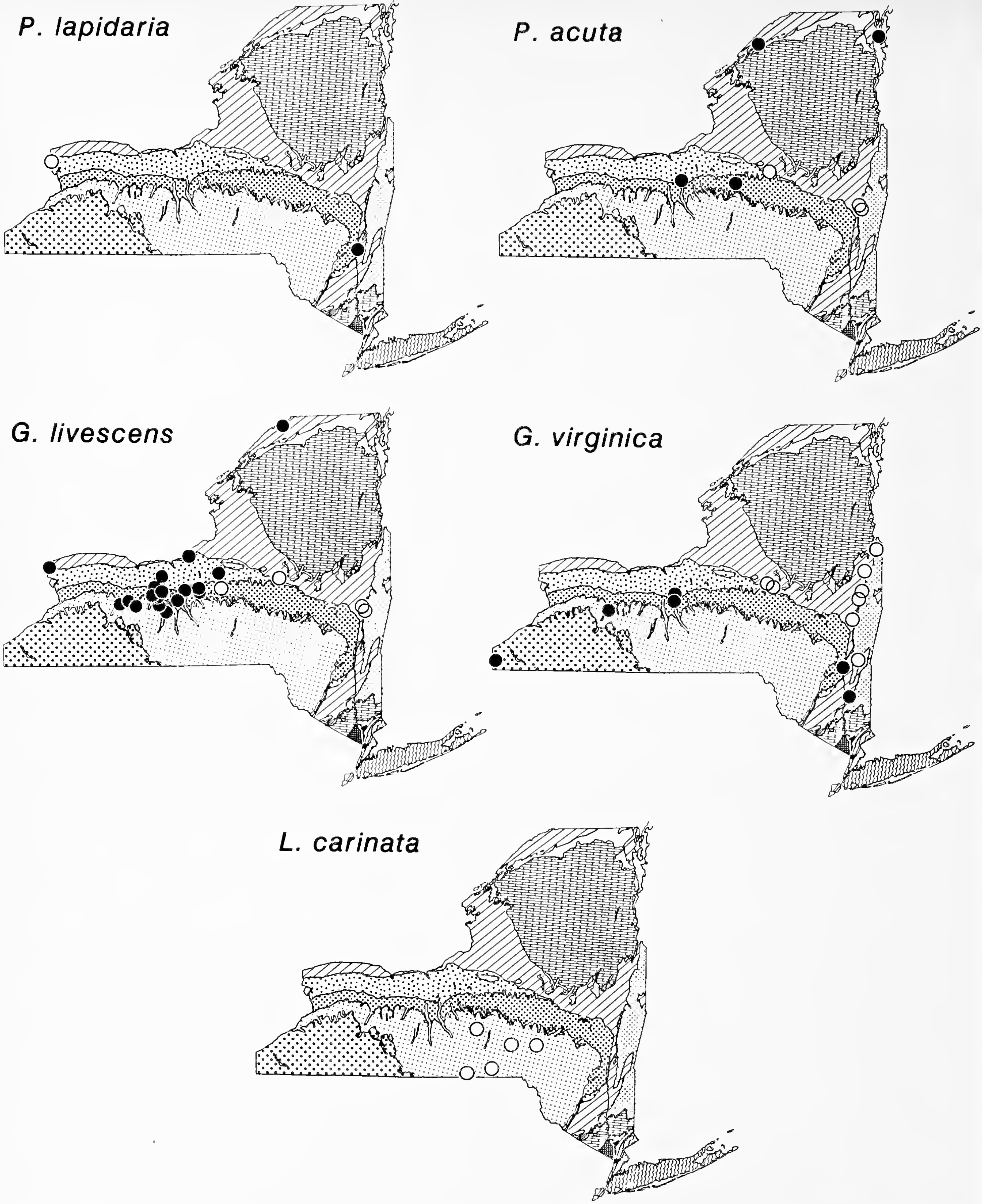


Fig. 13. Known distributions of *Pomatiopsis lapidaria* and species of Pleuroceridae in New York State. Closed circles indicate records from the present survey, and open circles indicate records from museum specimens.

Cortland County; Oneonta, Otsego County (Lewis 1874); and the Susquehanna and Chemung Rivers, Cortland County (Marshall 1894). More recent reports give sites that include Otsego Lake, Otsego County (Harman 1971, McNamara & Harman 1975); the Tioughnioga River, Broome County; the Susquehanna River, Otsego County; and the Unadilla River, Chenango, Otsego County (Aldridge 1982). Except for De Kay's (1843) possibly erroneous account, this species in New York is restricted to the Susquehanna River watershed.

It appears that *L. carinata* is restricted to riffle areas in larger rivers (Harman & Berg 1971), where it grazes on *Aufwuchs* (Aldridge 1982).

The snails live for two years and breed only once, in their second summer. In April, copulation occurs between 20-month-old snails. Oviposition begins when the water temperature rises to 18°C in late May or June. Afterward, all adult snails die. Egg deposition peaks in early June, and females produce an average of 13 eggs/m^2. Eggs are laid singly or in small masses up to an average of 296-381 eggs/female, but less than 10% of the eggs survive (Aldrich 1982). A population in Wood Creek, Pennsylvania, showed similar characteristics but oviposition began in late March (Hendrix 1986).

After an incubation period of 18-25 days, actively growing, young snails appear from August through October. A second season of growth occurs from May through August. At four sites in the Susquehanna River basin, mature colonies of snails have female to male ratios of 1.0:1.0 to 5.2:1.0 During the breeding period, female to male ratios are 1.4:1.0 to 6.6:1.0, and adult snail densities are 41-77 snails/m^2 (Aldrich 1982).

Subclass Pulmonata

Shell present or absent, spiral or saucer shaped; operculum absent. Primary gills absent; mantle cavity a functional lung, pseudobranch present or absent; species hermaphroditic and freshwater, terrestrial or, rarely, marine.

Order Basommatophora

Shell present, covered by corneous periostracum; single pair of tentacles present, flattened, triangular to subcylindrical, non-retractile; eyes sessile at tentacle base; species freshwater, amphibious, or rarely marine (Baker 1928a).

Egg capsule types for the basommatophoran families are illustrated in Bondeson (1950).

Family Lymnaeidae

Shell usually dextral, ovately-oblong or elongate; spire more or less attenuated; outer lip thin, sharp; columella axis thickened by shelly deposit; one large superior and two smaller, narrow, lateral jaws present; radula usually of 80-100 rows of overlapping teeth (Fig. 5b) (Baker 1928a).

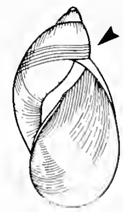
Lymnaeid taxonomic relationships are discussed in Baker (1911), Hubendick (1951), Walter (1969), and Burch (1982).

Key to the Lymnaeidae

1a. Aperture markedly longer than spire 2

1b. Aperture same length or shorter than spire 4

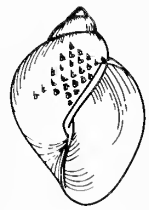
2a. Aperture lacrimate; shell tapered; body whorl with spiral lines ....*Pseudosuccinea columella*



2b. Shell not as above 3

3a. Aperture very large, flared, ear-shaped ....*Radix auricularia*

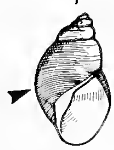
3b. Aperture not flared ....*Stagnicola emarginata*



4a. Shell very narrow, needle-like ....*Acella haldemani*

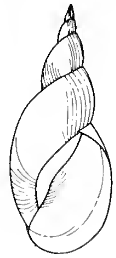
4b. Shell not as above 5

5a. Shell with distinct spiral lines caused by folds in periostracum ....*Stagnicola caperata*



5b. Shell without distinct spiral lines.......................................6

6a. Shell thin, pale, large, greater than 30 mm long; spire acute ....*Lymnaea stagnalis*



6b. Shell not as above 7

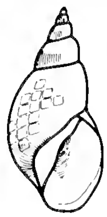
7a. Shell sturdy, dark brown, large, greater than 30 mm long ....*Bulimnea megasoma*

7b. Shell not as above 8

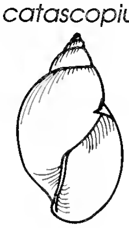
8a. Periostraum distinctly crenulated (Fig. 14a) ....*Stagnicola* spp., 9

8b. Periostracum not or only indistinctly crenulated (Fig. 14b) ....*Fossaria* spp., 10

9a. Spire elongate, usually longer than aperture ....*Stagnicola elodes*



9b. Spire short, same length or shorter than aperture ....*Stagnicola catascopium*



10a. Whorls shouldered...11

10b. Whorls rounded 12

11a. Whorls flattened; spire acute; shell elongate with whorls as high as wide; sutures deeply impressed...*Fossaria exigua*

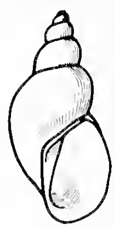
11b. Whorls below shoulder rounded; spire conic; whorls wider than high ....*Fossaria obrussa*

12a. Shell with five whorls less than 7 mm long; aperture ovate ....*Fossaria parva*

12b. Shell with five whorls greater than 8 mm long; aperture elongate..13

13a. Spire acute, usually longer than aperture, turreted; sutures very deeply impressed ....*Fossaria rustica*

13b. Spire broadly conic, usually as long as aperture; sutures not deeply impressed ....*Fossaria modicella*



Lymnaea stagnalis (Linnaeus, 1758)

Swamp lymnaea
Figs. 15a, 17

Shell elongate, thin, somewhat fusiform, yellow to brown, large, 50-60 mm high; umbilicus closed or a small chink; spire long, acutely pointed, flat-sided, approximately one-half length of aperture; whorls 7.0, early ones not rapidly increasing in diameter; body whorl rapidly expanding, rounded; sutures distinct, sometimes impressed; aperture ovate, somewhat dilated above, rounded below; outer lip thin, acute; parietal wall with thin callus appressed to umbilical region; columella pillar gyrate, forming heavy, oblique, ascending plait (Baker 1911, 1928a).

Information on internal anatomy can be found in Carriker (1946) and McDonald (1969).

The range of this species is circumboreal. In North America it exists south of the Canadian treeline from the St. Lawrence River in Quebec to the Mackenzie and Yukon River watersheds south to Colorado and the Mississippi River system in North Dakota, Ohio, and Illinois (Clarke 1973, 1981; Cvancara 1983). Populations also occur in the northern branches of the Susquehanna River system in central New York (Harman & Berg 1971). This species apparently does not occur in southern New England (Jokinen 1983).

During this survey, *L. stagnalis* was found associated only with the mouths of Lake Champlain tributaries, St. Lawrence River watershed (259A, 259B, 262, 263). However, Harman & Berg (1971) reported populations in the Oswego River system of the St. Lawrence River watershed: Seneca Lake, Ontario County; Cayuga Lake, Cayuga County; Little Sodus Bay, Lake Ontario, Oswego County; and Big Lake, Onondaga County. Additional sites reported by Harman & Berg (1971) were in the northeast region of the West Branch of the Tioughnioga River in the Susquehanna River drainage basin. Localities from museum collections are indicated on Fig. 17.

The literature on *L. stagnalis* includes mention of it as an inhabitant of Lake Champlain, Clinton County (De Kay 1843); Canandaigua Lake, Ontario and Yates Counties (De Kay 1843, Mitchell 1899, Maury 1916); Cayuga Lake, Seneca and Cayuga Counties (De Kay 1843); Conesus Lake, Livingston County (Wade & Vasey 1976); Oneida Lake, Oswego and Onondaga Counties (Beauchamp 1886b; Baker 1916a, b, 1918a, b; Pratt 1923); Erie Canal "Wide Waters," Monroe County (Baker 1900b); Niagara River (Letson 1909); Buffalo, Erie County (Lewis 1874); Genesee County (Marshall 1894); and Conesus Lake, Livingston County (Wade & Vasey 1976).

This species is primarily an inhabitant of quiet, shallow lakes, river embayments, and lake inlets and outlets (Dawley 1947), but a subspecies (*L. stagnalis lillinae* Baker 1910) is typical of sandy shores with heavy wave action (Goodrich 1932). Observations in Michigan (Goodrich 1932) indicate that *L. stagnalis* was much more abundant before lumbering, pollution and wetland drainage occurred. This species is a carnivore and a detritivore (Baker 1918a).

The longevity of these snails can be as short as one year (McDonald 1969), or it can be as long as seven years for

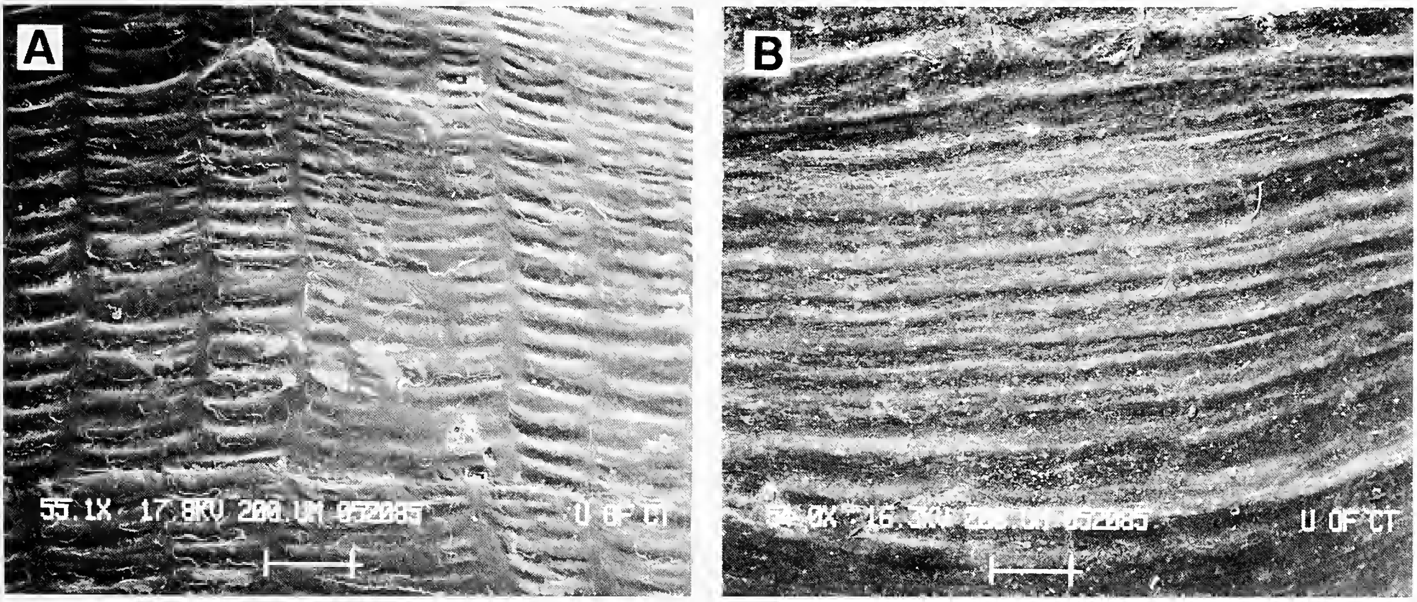


Fig. 14. Family Lymnaeidae, structure of the periostracum: a, *Stagnicola* sp., with numerous distinct crenulations between growth lines; b, *Fossaria* sp., with weak crenulations between growth lines or crenulations absent.

northern populations where ponds are ice-free for only five months of the year (Boag & Pearlstone 1979). Egg masses are deposited on species of *Nymphaea, Castalia,* dead *Typha,* and the floating leaves of *Potamogeton natans* L. (McDonald 1969). In northern populations, egg deposition occurs from mid May to late August, with a peak in May and June. Only snails with shells longer than 30 mm, in the second half of their third summer, are mature enough to deposit eggs. By their fourth summer, all snails are fecund, and egg production occurs for the remainder of life, making the reproductive pattern iteroparous. The average number of eggs/mass varies from 61-80 (Boag & Pearlstone 1979).

Under laboratory conditions, much of the mortality of newly hatched snails is caused by accidental ingestion by mature snails, especially at the air-water interface (Boag *et al.* 1984). The diet includes rooted vegetation, detritus at surface films where the snails hang upside down, and *Aufwuchs* covering submerged rocks, logs, etc. This species has been observed attacking small fish and feeding on fish eggs (McDonald 1969).

Lymnaea stagnalis has been shown experimentally to prefer substrata mimicking prostrate aquatic macrophytes, rocks, logs, debris, and dissected-leaved macrophytes (Kershner & Lodge 1990). In winter, as water temperatures decrease below 9°C, snails migrate into deeper water. At 2°C they are immobile and cling to any hard substratum until temperatures increase (Boag & Bentz 1980).

This species requires 20 ppm of calcium for growth (MacDonald 1969) and is best adapted to hard water. Water chemistry parameters for two of the sites located during this survey are: pH: 6.6 and 7.2, conductivity: 87 and 371 µmhos/cm, Ca^{++}: 9 and 44 ppm, and Na^{+}: 4 and 10 ppm. In Minnesota, this species occurs in soft as well as hard water (Dawley 1947).

Stagnicola elodes (Say, 1821)

Marsh pondsnail
Figs. 15b, 17

Shell elongate to elongate ovate, 35 mm long, thin, malleated, pale brown to black; umbilicus closed or narrowly open; spire sharp, pointed, 0.5-0.6 shell length; whorls 7.0, rounded; body whorl usually obese; sutures well-impressed; aperture roundly ovate to elongate ovate; outer lip thin, brown-purple varix within; columella axis twisted, forming heavy ascending columellar plait; callus heavy, formed by inner lip (Baker 1928a).

Synonyms are *Stagnicola palustris* (Müller) and *Lymnaea palustris.*

This species is distributed from New England to Manitoba and the Yukon, south to New Mexico and Kentucky (Baker 1928a, Clarke 1973, Goodrich & van der Schalie 1939, Branson & Batch 1983, Jokinen 1983).

Stagnicola elodes is widespread in New York except for the Delaware River watershed and the low calcium waters of the Adirondacks Mountains. The 48 sites where it was found are in the Hudson River watershed (212, 268, 269, 270, 271, 275, 318, 368, 451, 587); Ohio-Mississippi River watershed (417, 426); St. Lawrence River watershed (141A, 141B, 141D, 263, 307, 308, 337, 340, 390, 394, 396, 438, 441, 445A, 493, 494, 507, 508, 509, 521, 522, 526, 531, 532, 535, 559, 561, 566); and the Susquehanna River watershed (536, 537, 538, 541, 574, 590, 593).

This species has been known to be abundant in New York State since the middle of the 19th century (De Kay 1843). Lewis (1856b, 1860, 1872, 1874)) documents the snails in stagnant waters such as the Erie Canal and pools and ditches of Herkimer and Otsego Counties. Within a few years, populations were described from marshes at the foot of Owasco Lake, Cayuga County (Baker 1899); Onondaga County (Beauchamp 1886b); Erie Canal, Monroe County (Walton 1891); Jefferson, Rochester, and Niagara Counties (Marshall 1894); tidal creeks and brackish marshes of the Hudson River, Ulster and Orange Counties (Mearns 1898); New York City (Prime 1880); Canandaigua Lake, Ontario and Yates Counties (Mitchell 1899); Genesee River, Irondequoit Bay of Lake Ontario, and the Erie Canal at "Widewaters," Rochester, Monroe County (Baker 1900b, 1901); Cazenovia Lake, Madison County; Williamsville, Erie County; Goat Island, Niagara County (Letson 1909); in swales and swamps of Wyoming County (Baker 1913); Oneida Lake, Oswego County (Baker 1916a, b; Pratt 1923); Farm Creek, Ithaca, Tompkins County; and Cayuga Lake, Cayuga and Seneca Counties (Maury 1916).

More recently, *S. elodes* has been reported from the Salmon River, Wayne County; Oak Orchard Creek tributaries, Orleans County; and Little Sodus Bay in Lake Ontario, Cayuga County (Burdick 1939); Upper Ferdun Pond, between Piermont and Sparkill, Rockland County (Bretet & Carswell 1952); Brooklyn Botanic Gardens stream, Kings County (Freas 1950a); Crystal Brook, Mount Sinai, Suffolk County, Long Island, (Jacobson 1969); Oneida Lake and the Finger Lakes in Onondaga, Cayuga, Seneca, Steuben, and Ontario Counties (Harman & Berg 1971); Otsego Lake, Otsego County (Harman 1971; MacNamara & Harman 1975); the Hudson River basin, where the species is abundant but not in the main channel (Strayer 1975); and the lowlands surrounding the Adirondack Mountains (Jokinen 1991). The American Museum of Natural History has lots from a pond in Glen Cove, Long Island (AMNH 143436); Alley Pond, Hollis, Queens, Queens County (AMNH 143513); Bulls Head Pond, Staten Island, Richmond County (AMNH 143514); and Frerdon Pond, Sparkill, Rockland County (AMNH 143477).

This species is found in vernal and permanent ponds, marshes, edges of lakes and rivers, and ditches (Dawley 1947). It is frequently associated with cattails (*Typha* spp.). Of the 43 sites found during this study, 15 were edges of

rivers and streams, seven were lake littoral zones, nine were small permanent and vernal pools, seven were ditches, two were marshes, two were canals, and one was a swamp. Temporary ponds were under-collected during this survey, and it is probable that *S. elodes* is more abundant than noted here.

In most habitats, the snails live to approximately 14 months. Adults lay eggs in spring on any stiff surface, such as terrestrial leaf and branch litter, stones, and shells of other individuals. In temporary pools and ditches, older snails migrate to deeper areas as the water level drops, and they become stranded as the water disappears. Young snails, however, do not follow the water level. They climb up terrestrial vegetation, even as high as 2 m up trees, and they attach themselves with the mucus that they use to close their apertures as they withdraw deeper into the shell to aestivate. The adults are open to predation and parasitism from sciomyzid fly larvae and other organisms (Jokinen 1978a, Barnes 1990), and usually they do not survive the summer. Before a pond refills, the aestivating snails move about during rains, but they do not appear to feed. When the autumn rains arrive and the pond begins to fill, the young migrate down to under the newly-fallen leaf litter and hibernate until ice melt in spring. They actively feed and grow to mature size before oviposition (Jokinen 1978a, McGraw 1970).

Stagnicola elodes appears to have a relatively high phenotypic plasticity which allows the individuals to survive at various levels of nutrition (Rollo & Hawryluk 1988). Populations exist in habitats with both low and high gastropod species diversity (Jokinen 1987). Physiological studies have been done by Hunter (1975a, b).

This species prefers submerged terrestrial leaf litter as its substratum, and individuals feed on the algae and bacteria covering it. Life history patterns and fecundity appear to be determined by the food quality and habitat trophic status (Eisenberg 1966, 1970; Hunter 1975b). In permanent habitats, *S. elodes* can have two generations each year (Hunter 1975b).

Forty-three collecting sites sampled during this survey had the following water chemistry parameters: pH: 6.0-8.4 (7.3 ± 0.1), conductivity: 84-2320 µmhos/cm (509 ± 67), Ca^{++}: 4-94 ppm (27 ± 3), and Na^{+}: 1-291 ppm (39 ± 8). In Connecticut, *S. elodes* was not abundant (12 sites) and tended to dwell in the harder waters of the Connecticut Valley. Connecticut water chemistry parameters were: pH: 6.2-7.9, conductivity: 63-387 µmhos/cm, Ca^{++}: 3-26 ppm, Na^{+}: 4-41 ppm (Jokinen 1983). In New York, this species is rare in the acidic, low calcium waters of the Adirondack Mountains (Jokinen 1991).

Stagnicola emarginata (Say, 1821)

St. Lawrence pondsnail
Figs. 15c, 17

Shell ovate to globose, inflated, up to 30 mm high, thin, malleated, nearly three-quarters as wide as high, translucent, white to dark brown; umbilicus a small chink to wide perforation, margined by inner lip; spire broadly, acutely pyramidal to depressed globose or flattened, often eroded; nuclear whorls 1.5, chestnut, wide, low, flattened; whorls 5.0-6.0, convex to subglobose, shouldered; body whorl large, convex, expanded, flared; sutures deeply impressed, sometimes bordered by white line; aperture ovate, large, 0.5-0.7 times shell length; outer lip thin, with thin white-brown varix; inner lip white, broadly reflected; columella smooth to plicated; parietal callus thick, raised to make aperture continuous (Baker 1928a, Goodrich 1932).

Information on anatomy can be found in Baker (1900a).

There has been an off-and-on synonymy of *S. catascopium* with *S. emarginata* dating back to Binney (1865). Strayer (1987) considers them to be a single species. For purposes of the present work, they are considered separate species.

S. emarginata occurs from Maine to western Ontario, south to Michigan, Pennsylvania, and New York State (Baker 1911, 1928a).

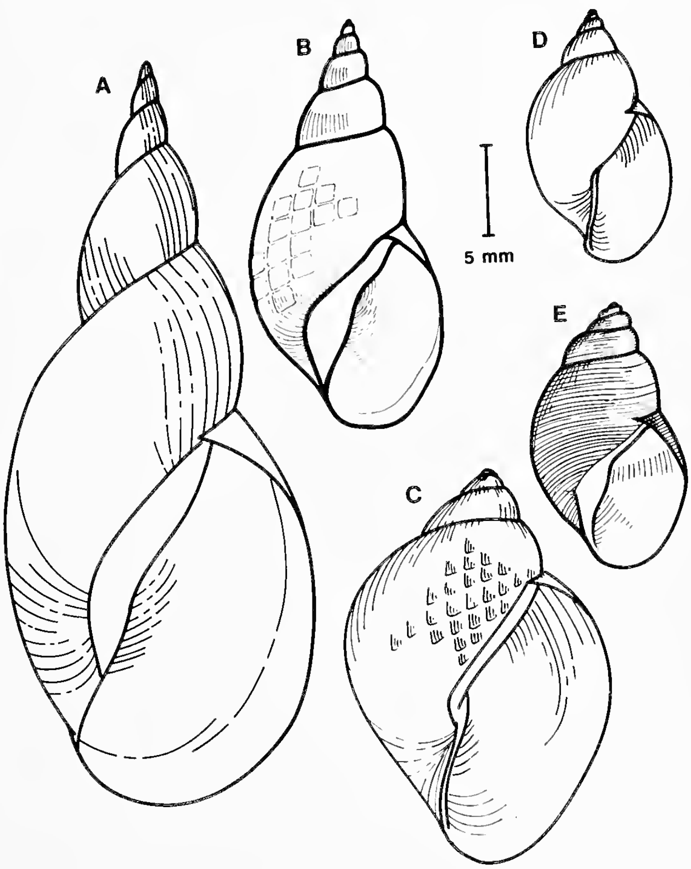


Fig. 15. Family Lymnaeidae, shells: a, *Lymnaea stagnalis*; b, *S. elodes*; c, *S. emarginata*; d, *S. catascopium*; e, *S. caperata*. All illustrations are drawn to the same scale.

This species was not found to be abundant in New York State. Sites were in the Hudson River watershed (460) and the St. Lawrence River watershed (398, 524A, 525, 531).

S. emarginata has been reported from the Mohawk River (De Kay 1843); Owasco Lake and Owasco River, Cayuga County (Lewis 1874, Baker 1899); Onondaga County (Beauchamp 1886b); Chautauqua Lake, Chautauqua County (Maury 1898, 1916; Townes 1937); Canandaigua Lake, Ontario and Yates Counties (Mitchell 1899); Cazenovia Lake, Madison Country (Henderson 1907); Oneida Lake, Oswego and Onondaga Counties (Baker 1916a, b; Pratt 1923; Harman & Berg 1971); Skaneateles Lake, Onondaga County, and Keuka Lake (shells only), Steuben County (Harman & Berg 1971); and Otsego Lake (shells only), Otsego County (Harman 1971, MacNamara & Harman 1975). Most localities are in central and western New York.

The habitats found during this survey included one lake, one ditch draining into a lake, and two canals. In Minnesota, the snails are especially adapted to large, hard water lakes (Dawley 1947). Studies at a Michigan lake revealed densities of up to 5 snails/m^2 on variable substrata (Clampitt 1973). In Skaneateles Lake, a population lived in water 3-15 m deep on sand or silt (Harman & Berg 1971).

Little has been documented on the life history of *S. emarginata*. During the summer in Michigan, the snails are in deep water (4 m), but they migrate to shallow water in the autumn and half bury themselves in sand (Goodrich 1932). In Oneida Lake, New York, they occur on bouldered shores (Baker 1918a).

Water chemistry values for four sites in New York are: pH: 7.6-8.4 (7.9 ± 0.2), conductivity: 240-1240 μmhos/cm (721 ± 209), Ca^{++}: 26-58 ppm (36 ± 8), and Na^{+}: 1-144 ppm (86 ± 30).

Stagnicola catascopium (Say, 1817)

Woodland pondsnail
Figs. 15d, 17

Shell short-ovate to elongate fusiform, 25 mm high, thin to thick, pale brown to dark chestnut; umbilicus closed or a small, narrow chink; apex acute; nuclear whorls small, well-rounded, white to wine colored; spire short, depressed, dome-shaped to turreted, acutely conical or pyramidal; whorls 5.0-6.0; body whorl large, moderately convex; sutures impressed, almost channeled; aperture ovate or elongate ovate, as long as or longer than spire; outer lip thickened by varix edged with narrow chestnut band; inner lip reflected, appressed to columellar region; columella with heavy oblique plait; axis twisted; callus thickened (Binney 1865, Baker 1928a).

This species occurs from Nova Scotia west to the Pacific coast and south to about 40°N. It is present, but rare, in western New England and common in all the Great Lakes except Lake Superior (Baker 1928a, Goodrich & van der Schalie 1939, Clarke 1981, Jokinen 1983, Cvancara 1983).

Stagnicola catascopium was found at 19 sites in the Hudson River watershed (96I, 287, 370, 588, 589); Mississippi-Ohio River watershed (431, 432); St. Lawrence River watershed (141D, 259B, 260, 261, 339, 341, 352, 450, 524B); and the Susquehanna River watershed (567, 572, 591).

De Kay (1843) reported that *S. catascopium* was common in western New York. In the 19th century, populations were found in the Erie Canal, Herkimer County (Lewis 1860, Baily 1891); Onondaga County (Beauchamp 1886b); the Hudson River from Albany, Albany County, and Troy, Rensselaer County, the Normanskill, and the Mohawk River (Marshall 1895); Hudson River marshes, Orange and Ulster Counties (Mearns 1898); Chautauqua Lake, Chautauqua County (Maury 1898, 1916; Townes 1937); and Rochester, Monroe County (Walton 1891). Later, the snails were reported from Oneida Lake, Oswego and Onondaga Counties (Baker 1916a, b, 1918a, b; Pratt 1923); the Erie Canal "Wide Waters" in Rochester and the Genesee River, Monroe County (Baker 1900b, 1901, 1909); Niagara Falls, Niagara County; Lake Erie at Rose Hill, Erie Canal, and Frenchman's Creek (Letson 1909); Canandaigua Lake, Ontario and Yates Counties (Mitchell 1899). Later reports note this species from Lake Ontario near Oswego, Oswego County (Burdick 1939); the Hudson River from Hudson, Columbia County, to Verplanck, Westchester County (Townes 1936); Seneca Lake, Seneca and Yates Counties; Oneida Lake, Onondaga County; and Cross Lake, Onondaga and Cayuga Counties (Harman & Berg 1971). The American Museum of Natural History has lots from Niagara Falls, Niagara County (AMNH 143456); and the Hudson River, Highland Falls, Orange County (AMNH 143437).

Habitats include lakes, rivers, and streams. Young snails usually are found on mud, clay, and sand in deep water, whereas adults are more likely to live on boulders in shallow water, often in areas of heavy wave action (Binney 1865, Baker 1928a, Goodrich 1932, Goodrich & van der Schalie 1939). They actively migrate inshore (Boss *et al.* 1984). In Oneida Lake, *S. catascopium* is associated with filamentous algae (*Oedogonium, Cladophora,* and *Spirogyra* spp.) (Baker 1918a).

These snails consume organic detritus and algae, especially diatoms (Pinel-Alloul & Magnin 1979). The young snails are prey of the common sucker (*Catostomus commersoni* (Lacepède)) and the pumpkinseed (*Lepomis gibbosus* (L.)) (Baker 1918a, 1928a).

Stagnicola catascopium serves as an intermediate host for the swimmers' itch trematode, *Schistosomatium douthitti* Cort. Effects of infection on snail life cycle characteristics are described by Loker (1979).

Water chemistry values for 14 of the New York State sites were: pH: 6.4-7.8 (7.1 ± 0.1); conductivity: 47-760 μmhos/cm (275 ± 47); Ca^{++}: 3-49 ppm (16 ± 4); and Na^{+}: 1-122 ppm (19 ± 8). This species is able to tolerate the salinity of tidal rivers (Binney 1865; Jokinen 1983).

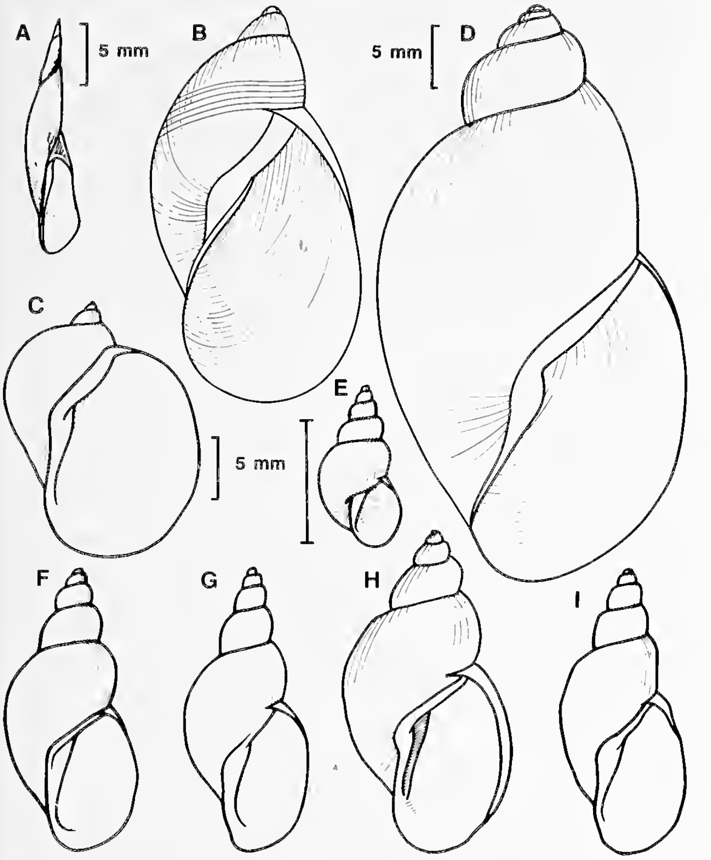


Fig. 16. Family Lymnaeidae, shells: a, *Acella haldemani*; b, *Pseudosuccinea columella*; c, *Radix auricularia*; d, *Bulimnea megasoma*; e, *Fossaria parva*; f, *F. modicella*; g, *F. rustica*; h, *F. obrussa*; i, *F. exigua*. Figs. a, c, and d are drawn to the same scale and Figs. b, e, f, g, h, and i are drawn to the same scale, twice that of a, c, and d.

Stagnicola caperata (Say, 1829)

Wrinkled pondsnail
Figs. 15e, 17

Shell ovately elongate, 17 mm high, turreted, solid, encircled by numerous, equidistant, heavily impressed, spiral lines, yellowish-tan to black; umbilicus narrow, deep; spire acutely conical, longer than aperture; nuclear whorl deep wine or brown; whorls 6.0-6.5, convex; sutures impressed; aperture ovate, reddish or purple within; inner lip reflected over umbilicus to form wide, smooth, triangular expansion; columella not twisted; callus thin (Binney 1865, Baker 1928a).

Comparative anatomical information can be found in Taylor *et al.* (1963).

This species occurs from southern Manitoba to southern Alberta, south to Nevada, North Dakota, Utah, Indiana, and the District of Columbia (Binney 1865, Baker 1911, Richards 1934, Taylor *et al.* 1963, Clarke 1981, Cvancara 1983).

Literature records for *S. caperata* are few. De Kay (1843) noted populations in the Mohawk River and Sandy Pond near Lake Ontario, Oswego County. Other sites listed in 19th and early 20th century records are Onondaga County (Beauchamp 1886b); Pittsford, Monroe County (Walton 1891); Litchfield, Herkimer County (Marshall 1894); Albany/Troy area, Albany and Rensselaer Counties (Marshall 1895); New York City (Prime 1880); and the Genesee River, Monroe County (Baker 1901). More recently, Buckley (1977) found two populations in ditches in Lewis County. No individuals of this species were located by Harman & Berg (1971) in central New York, by Strayer (1987) in the lower Hudson watershed, or during this survey. The American Museum of Natural History has a lot from Monroe County (AMNH 143455).

Stagnicola caperata is a common inhabitant of temporary ponds in wooded areas, ditches, sloughs, and shallow ponds (Baker 1911, Goodrich 1932, Dawley 1947, Taylor *et al.* 1963). Life history information seems to be unavailable. Temporary habitats were undersampled in New York State, so it is possible that this species is more common than presently known.

Acella haldemani (W.G. Binney 1867)

Spindle lymnaea
Figs. 16a, 17

Shell slender, 26 mm high, five times higher than wide, thin, fragile, yellowish white to brown; umbilicus a small chink; spire slender, acute, much longer than aperture; nuclear whorl elongate oval, resembling end of bullet; whorls 5.5, oblique, flat sided; sutures heavily impressed, bordered by narrow band; aperture elongate oval, narrow, 40% shell length, continuous, twisted to left; outer lip thin, acute; inner lip sometimes elevated; columella straight, not plaited (Baker 1928a, Clarke 1981).

This species occurs in the Great Lakes-St. Lawrence River drainage from southeastern Ontario, southern Quebec, and northern Vermont west to northern Minnesota and south to northern Illinois (Baker 1928a, Clarke 1981).

No colonies of *A. haldemani* were found during this survey or that of Strayer (1987). Harman & Berg (1971) located one colony in Oneida Lake, Oswego County.

Historically, this species (previously known as *Lymnaea gracilis* Jay) has been recorded from Lake Champlain, Clinton County (De Kay 1843); Schuyler Lake, Otsego County (Whittemore 1859; Lewis 1860, 1872); the Niagara River, Niagara County (Lewis 1874, Letson 1909); and Oneida Lake, Oswego and Onondaga Counties (Baker 1916a, b; 1918a, b; Pratt 1923; Harman & Berg 1971). The American Museum of Natural History has specimens from Strawberry Island, Niagara River, Niagara County (AMNH 70426 and part of 70464); Schuyler Lake, Otsego County (part of AMNH 70464, Crooke Collection, date: mid- to

late 19th century); and Lake Champlain (part of AMNH 70464, Crooke Collection).

Acella haldemani has a scattered distribution in lakes, often found in only one location in the lake, and, therefore, it is easily overlooked (Dawley 1947). Substrata include submerged logs, silt, sand, and mud in water 0.3-2.0 m deep. The snails are usually attached to leaves and stems of pondweed (*Potamogeton interruptus* Kit., *P. natans* L.), bulrushes (*Scirpus smithii* Gray), flag (*Iris* spp.), floating cattails (*Typha* sp.), and water lilies (*Nymphaea odorata* Ait. and *Nuphar advena* (Ait.) Ait.). Young snails resemble leaves of submerged vegetation (Whittemore 1859; Baker 1918a, b; Morrison 1932; Herrington 1947; Harman & Berg 1971).

Individuals are usually found, spire down, firmly gripping reeds and rushes about 20 cm above the bottom (Goodrich 1932). They tend not to travel far from where they hatch, thus causing clumped populations. This species has an annual life cycle. One month after ice melts on the lake, eggs are laid in masses of 3-12 on rushes (*Juncus* sp.), dead and decaying pondweeds, burreed (*Sparganium* sp.), and small sticks and logs at the bottom. The young begin to hatch in about ten days. Juveniles grow rapidly, reaching full size by autumn. These individuals hibernate through winter, lay eggs in spring, and they die by midsummer (Morrison 1932).

Little is known about the chemical tolerances of this species. In Wisconsin, three populations studied by Morrison (1932) were in lakes with pH values of 7.4-7.7. Harman & Berg (1971) note that Oneida Lake, the one lake in which they located a population, had a pH of 8.1.

Pseudosuccinea columella (Say, 1817)

Mimic lymnaea
Figs. 16b, 17

Shell ovate, somewhat pointed, variable, 25 mm high, thin, fragile, translucent light green to yellow tan; umbilicus a narrow chink or closed; spire sharply conical, short; sculpture of impressed spiral lines; apex small, dark brown; whorls 4.0, well-rounded, rapidly enlarging; body whorl three times higher than spire; sutures lightly appressed; aperture ovate, dilated, expanded at lower part; outer lip thin, acute; inner lip closely appressed to body whorl, reflected over umbilicus; columella narrow (Baker 1928a).

In North America this species occurs from Nova Scotia south to Florida and west to Wisconsin, Arizona, central Texas and central and southern California (Baker 1928a, Richards 1934, Alexander 1947, Dawley 1947, Rehder 1949, Russell 1971, Taylor 1981, Jokinen 1983, Thompson 1984a). It extends into South America (Malek & Chrosciechowski 1964, Malek & Cogswell 1980, Gomez *et al.* 1986) and has been introduced into South Africa, South Mozambique, Rhodesia, Zambia, and Egypt (see references in Brown 1980). An introduction into New Zealand has resulted in increased incidence of sheep liver fluke (Pullan *et al.* 1972; Harrison & Charleston 1976, 1977).

Pseudosuccinea columella is a common snail in New York State and was found at 71 sites in all major drainage basins: Delaware River watershed (457, 466, 468, 470, 474, 475); Hudson River watershed (276, 283, 285, 287, 290, 292, 293, 300, 301, 305, 317, 367, 383, 386, 455, 589, 599, 607, 611, 613); Ohio-Mississippi River watershed (420, 421); St. Lawrence River watershed (141D, 278, 298, 314, 316, 331, 332, 334, 338, 341, 349, 352, 353, 356, 358, 361, 366, 371, 377, 390, 396, 397, 409, 495, 496, 497); Susquehanna River watershed (540, 552, 553, 568, 569, 571, 572, 573, 574, 576, 577, 578, 580, 581, 582, 593); and Long Island coastal river system (322).

This species was first reported from the locks at Schenectady, Schenectady County, and from the western part of the State (De Kay 1843). Lewis (1856a, b; 1860; 1874) found *P. columella* populations in the lakes of Herkimer and Otsego Counties, but he believed the species was not abundant. Hubbard & Smith (1865) found it to be common on Staten Island, Richmond County, and Prime (1880) noted populations in New York City. Beauchamp (1886b) cited the Seneca River, Onondaga County, as having the species, and Walton (1891) noted sites in the Erie Canal, Monroe County. Marshall (1894) added records from Fort Hamilton, Long Island, Kings County; and Little Lakes, Herkimer County. Mearns (1898) found one specimen from Highland Falls, Orange County. Wheat (1907a) found *P. columella* living in all streams and ponds of Long Island, and Letson (1909) recorded populations in Park Lake, Buffalo, Erie County. The species has been found in Oneida Lake, Oswego and Onondaga Counties (Baker 1916a, b; 1918a, b; Pratt 1923; Harman & Berg 1971); Chautauqua Lake, Findley Lake, Bear Lake, Upper Cassadaga Lake, and Middle Cassadaga Lake, all in Chautauqua County (Maury 1898, Townes 1937); Otsego Lake, Otsego County (Harman 1971, MacNamara & Harman 1975); Cazenovia Lake, Madison County (Henderson 1907); Cayuga Lake, Seneca and Cayuga Counties; Conesus Lake, Livingston County; Cayuta Lake, Schuyler County (Maury 1916, Robertson & Blakeslee 1948); Lake Ontario (Burdick 1939); and the backwaters of Quaker Run in Allegany State Park, Cattaraugus County (Pinney & Coker 1934). The American Museum of Natural History has lots from Great Neck, Nassau County, Long Island (AMNH 143438); Princess Bay, Staten Island, Richmond County (AMNH 143444); Lake Allendale, Westchester County (AMNH 143478); and Center Moriches, Suffolk County, Long Island (AMNH 143488).

P. columella is primarily a still water species, frequently occurring in marshes, backwaters, lake littoral zones, ponds, and ditches. The snails glide on the underside of water lily leaves (*Nymphaea* sp.), on filamentous algae (e.g., *Oedogonium*), near cattails (*Typha* spp.) and other reeds, and on water hyacinths (*Eichhornia crassipes* (Mart.) Solms) (Baker 1918a, b; 1928a; Branson & Batch

1983; Jokinen 1983; Thompson 1984a). They are also common on decaying, submerged, terrestrial vegetation; rocks and occasionally sand, clay, and mud (Baker 1918a, Harman 1972, Jokinen 1983). These omnivorous snails prefer filamentous green algae over detritus as food (Kesler *et al.* 1986). Populations frequently exist in habitats with 3-10 other snail species. In habitats of even higher diversity the frequency of *P. columella* declines, indicating a possibly limited competitive ability (Jokinen 1987). However, colonization abilities appear to be good, and this species is found in high altitude habitats that have few other snail species (Jokinen 1991).

In temperate zones, *P. columella* can have two distinct breeding periods with complete replacement of the older generation by the younger one in spring. The early-hatching spring generation snails can become mature enough to lay eggs in late summer through autumn. The second generation snails continue to grow until December, hibernate inshore during winter, and begin to lay eggs when the water warms to 20°C in spring (Jokinen 1985). Experimental studies on a Florida population recorded life spans of 187-220 days and fecundity of 384 eggs/adult in each breeding season (McKillop & Harrison 1972). In other laboratory experiments, snails reached a mean age of 82-86 days before they oviposited, and both paired and isolated individuals produced viable eggs (Winsor & Winsor 1935). Some are as young as 40 days when they become reproductive (DeWitt & Sloan 1958). Snails living up to 139 days produce up to 725 eggs/snail with clutch sizes of 16-25 eggs (Baily 1931).

Mortality and shell size distribution in natural habitats can be greatly affected by predation by water bugs, *Belastoma* sp., (Hemiptera: Belostomatidae) (Kesler & Munns 1989).

Water chemistry parameters for 70 sites studied in New York State are: pH: 5.8-9.5 (7.0 ± 0.1), conductivity: 39-905 µmhos/cm (197 ± 19), Ca^{++}: 1-49 ppm (12 ± 2), and Na^{+}: 1-117 ppm (12 ± 2). Fifty-eight Connecticut sites also had wide ranges in chemical parameters: pH: 5.7-10.0, conductivity: 31-319 µmhos/cm, Ca^{++}: 1-23 ppm, and Na^{+}: 2-22 ppm (Jokinen 1983). This species is highly tolerant of low pH habitats with little calcium (Jokinen 1983, 1991).

Radix auricularia (Linnaeus, 1758)

Big-ear radix
Figs. 16c, 18

Shell inflated, 30 mm high, thin, fragile, tan to yellow; umbilicus a wide chink or covered; spire broadly concave; whorls 4.0-5.0; body whorl extremely inflated; sutures deeply impressed; aperture broadly lacrimate, earlike, sometimes same height as spire; outer lip thin, reflected in mature specimens; inner lip appressed to whorl above, reflected over plaited columella (Jacobson & Emerson 1961, Harman & Berg 1971).

This species is European and Asian (see Hubendick 1951) and has been introduced sporadically into North America. Populations have been found in the Canadian Interior Basin, in Bow River, Calgary, Alberta (Clarke 1973); Alaska; New Mexico; Colorado; Wyoming; California; Kentucky; and Vermont (Henderson 1918, Johnson 1945, Ingram & Kenyon 1947, Hubendick 1951, Beetle 1960, McCoy 1964, Branson & Batch 1969, Metcalf & Smart 1972). Eggs have been imported with plants from Belgium, and individuals probably arrived at the Great Lakes via the European-American lumber trade (Goodrich 1932, Wurtz 1956).

Only one population of *R. auricularia* was found during this survey: St. Lawrence River watershed, Niagara River (437). Jacobson & Emerson (1961) reported a population in Prospect Park, Brooklyn, Kings County, and at Cazenovia, Madison County. Harman & Berg (1971) found living animals at the Owasco Lake outlet, Onondaga County. The New York State Museum has recent specimens from Eldridge Swamp, Cambridge, Washington County (NYSM 2003, 2004).

There are only a few literature references to this species, and all are from Brooklyn. Call (1902) and Vanatta (1902) noted a population in a pond in Flatbush, Kings County. The snails might have been introduced on plants (Vanatta 1902). Another population was found in the lily ponds of Prospect Park, Brooklyn, Kings County (Wheat 1907a, b).

One population located by Harman & Berg (1971) lived in Owasco Lake outlet on boulders and vegetation both in and out of the direct current. A second population existed in a nearby anoxic strandpool of the outlet.

Water chemistry values for site 437 were: pH: 7.9, conductivity: 300 µmhos/cm, Ca^{++}: 27 ppm, and Na^{+}: 10 ppm.

Bulimnea megasoma (Say, 1824)

Mammoth lymnaea
Figs. 16d, 18

Shell ovate, inflated, large, 50 mm high, dark brown, green, or olive, often with longitudinal streaks of green, orange, or purple; umbilicus closed by callus; spire elongated to depressed, dome-shaped; apex with 1.3 nuclear whorls, yellow-tan to dark chestnut, outline of second whorl shouldered near suture of first whorl; whorls 5.0-5.5, rounded, somewhat flattened at previous suture; sutures impressed; aperture large, subovate, inflated, 0.5-0.7 shell length, acutely angled above, sharply rounded below, chestnut or dark purple within; peristome thin; columella plaited; callus thin, prominent, tightly appressed to body whorl (Baker 1928a).

This large lymnaeid is distributed throughout the St. Lawrence River drainage from northern Vermont (Lake Champlain and its tributaries) and Quebec, west to Manitoba and Minnesota, and south to upper tributaries of the Mississippi River watershed in Ohio, Wisconsin, Minnesota and Iowa (Baker 1928a, Goodrich 1932, Dawley 1947, Clarke 1973).

No populations of *B. megasoma* were found during this survey, and none were reported by Harman & Berg (1971) or Strayer (1987).

The New York and Vermont literature on this species is limited to a few 19th century reports from Lake Champlain (De Kay 1843, Lewis 1874, Marshall 1894). The American Museum of Natural History has specimens from Canton, St. Lawrence County (AMNH 1815, dated 1882); Burlington, Vermont (AMNH 130173, dated 1867); and Lake Champlain (AMNH 40564). Never abundant, this species might be extinct in New York.

Habitats of this species include ponds, large and small lakes, and shallow, quiet embayments of rivers where vegetation is sparse to thick. Substrata are of all kinds (Goodrich 1932, Dawley 1947, Clarke 1973, Jokinen, unpublished data). The life span has been estimated to be 14 months (Gilbertson *et al.* 1978), but it might be longer (Jokinen, unpublished data).

Bulimnea megasoma appears to have a tolerance to wide ranges of water chemistry parameters. In a series of lakes from northwestern Minnesota, pH was 5.5-9.3, and calcium concentration (except for a bog at pH 5.5) was 24-179 ppm (Gilbertson *et al.* 1978).

Fossaria parva (I. Lea, 1841)

Pygmy fossaria
Figs. 16e, 18

Shell small, 10 mm high, solid, turreted, translucent, light tan or yellow-white; umbilicus open; spire elevated, acute, generally longer than aperture; nucleus rounded, first whorl large; 5.0-5.5 whorls, convex, regularly increasing in size; sutures deeply impressed; aperture roundly and regularly elliptical, sometimes continuous; outer lip thin, with varix, inner lip broadly reflected over umbilicus; callus well-marked, thick (Baker 1928a, Goodrich 1932).

The range of this species includes southern New England west to California (north of 36°N), southeast to Arizona and New Mexico (Baker 1911, Johnson 1915, Clarke 1973, Taylor 1981, Jokinen 1983).

No New York populations were found during this survey.

Strayer (1987) noted the existence of scattered museum specimens of *F. parva* from New York, but he did not locate populations in the Hudson River watershed.

There is little information on *F. parva* in New York.

Buckley (1977) described several populations from the Black River system in and west of the Adirondack Mountains. There are no other references to this species in New York State, although its existence in Connecticut (Jokinen 1983) and states west of New York would indicate it is probably present but overlooked due to its habitat.

Habitats of *F. parva* include wet, marshy places. The snails can be amphibious, depending upon humidity and temperature (Hoff 1936, 1937). They are often out of water, on sticks, stones, or muddy flats of temporary ponds and intermittent streams (Jokinen 1983). In northern parts of its range, this species inhabits permanent bodies of water (Clarke 1973). It has an annual life cycle (Hoff 1936, 1937).

Fossaria parva in three Connecticut sites lived in acidic, low calcium habitats: pH: 4.9-6.8, conductivity 49-85 µmhos/cm, Ca^{++}: 2-5 ppm, Na^{+}: 2-3 ppm (Jokinen 1983).

Fossaria modicella (Say, 1825)

Rock fossaria
Figs. 16f, 18

Shell elongate-oval or fusiform, 15 mm high, light yellowish-tan; umbilicus small, narrow, distinct; apex with 1.3 nuclear whorls, first small, second large; whorls 5.0-5.5; body whorl large, flatly rounded; sutures well-impressed; aperture ovate or elongate ovate, narrowed above, 45-55% of shell height; outer lip thin; inner lip narrow, reflexed over umbilical region, rolled over, appressed at contact point with parietal wall (Baker 1928a, Clarke 1981, Jokinen 1983).

This species is widespread in North America south of the tree line in Canada and Alaska, south to southern California, Arizona, Texas, Alabama, and northern Florida (Baker 1928a, Clarke 1981, Thompson 1984a).

Except for the Adirondack Mountain region, *Fossaria modicella* is common in New York (61 sites): Delaware River watershed (458, 471); Hudson River watershed (288, 290, 367, 387, 453, 459, 460, 588); Ohio-Mississippi River watershed (426, 427A, 428, 429, 431); St. Lawrence River watershed (334, 335, 343, 344, 371, 373, 375, 401, 412, 436, 439, 442, 444, 445A, 495, 496, 497, 498, 500, 501, 503, 506, 511, 513, 516, 517, 520, 525); Susquehanna River watershed (389, 391, 400, 539, 546, 551, 554, 558, 572, 573, 575, 577, 582, 585, 586, 592, 594); and Housatonic River watershed (294).

This species was first reported (as *F. humilis* (Say)) in New York State from near the Susquehanna River at Owego, Tioga County (De Kay 1843). Additional sites included stagnant pools and the margins of streams and lakes in Herkimer County (Lewis 1860, 1872); Staten Island, Richmond County (Hubbard & Smith 1865); Onondaga County (Beauchamp 1886b); Cazenovia Lake, Madison County (Henderson 1907); Dweyers Pond, Ithaca, Tompkins County (Maury 1916); Oneida Lake, Oswego County; Tuttle Creek, a tributary of Chittenango Creek, Madison County (Baker 1918a, b); Chautauqua Lake, Chautauqua County (Baker 1928a); Stilsons Pond near Randolph, Cattaraugus County (Pinney & Coker 1934); Clymer Pond in the Allegheny River watershed, Chautauqua County (Townes 1936); Little Sodus Bay in Lake Ontario, Cayuga County; Red Creek Pond, Wayne County (Burdick 1939); and in Adirondack State Park, Warren County (Jacobson 1945). More recently, *F. modicella* has been found in Otsego Lake and New Pond, Otsego County (Harman 1971, MacNamara & Harman 1975); Canadarago Lake and Richfield Springs, Otsego County (Harman 1973).

The New York sites found during this survey were 31 river and stream sites, seven lake sites, 17 ponds, two ditches, and four canals. Habitats are often temporary ponds

(Goodrich 1932, Jokinen 1983). Baker (1918a) noted that, in Oneida Lake, the snails were common among floating filamentous algae (*Oedogonium* sp.), and on clay and mud substrata in water less than 15 cm deep. In a creek near Oneida Lake, they were in shallow water among *Oedogonium* sp. and *Cladophora* sp. (Baker 1918a). *F. modicella* also tends to live amphibiously in habitats such as vertical, sandstone cliffs and drying, flat, muddy beaches (van Cleave 1933, Dawley 1947). Individuals can produce two broods a year (van Cleave 1935).

Chemical parameters for 60 sites were: pH: 6.1-9.7 (7.4 ± 0.1), conductivity: 48-1240 µmhos/cm (353 ± 32), Ca^{++}: 2-70 ppm (24 ± 2), and Na^{+}: 1-144 ppm (22 ± 4). Connecticut data for 24 sites were: pH: 5.7-8.9, conductivity: 53-286 µmhos/cm, Ca^{++}: 2-35 ppm, and Na^{+}: 3-29 ppm (Jokinen 1983). This species is able to exist over a wide range of chemical values, including low calcium and high sodium.

Fossaria rustica (I. Lea, 1841)

Country fossaria
Figs. 16g, 18

Shell elongate, subfusiform, small, 11 mm high, light yellow to tan; umbilicus a narrow chink; spire long, acute, slightly longer than aperture; whorls 5.0-5.5, convex, slowly increasing in diameter; body whorl large; sutures impressed; aperture narrowly elliptical; outer lip thin, sometimes with a varix; inner lip narrow, reflected; lower part turned up; upper part at its junction with parietal wall impressed and flattened, forming a slight plait (Baker 1911).

This species was considered by Baker (1911, 1928a) to be a subspecies of *F. humilis* and later as a subspecies of *F. modicella*. However, the chromosome number differs from that of other *Fossaria* spp. (Burch 1960). It is being treated here as a species with the warning that the taxonomy of *Fossaria* needs revision (Burch 1982).

F. rustica occurs from Connecticut northwest to the Northwest Territories and south to Utah, Nebraska, and New Mexico (Baker 1928a, Clarke 1973).

Eleven sites in New York had populations of *F. rustica:* Delaware River watershed (463); Hudson River watershed (277, 290, 317); St. Lawrence River watershed (141A, 280, 309, 560, 563, 565); and the Susquehanna River watershed (583).

There appear to be no historical notes on this species for New York.

Three of the populations found during this survey were in rivers and streams, three in lakes, three in ponds, one in a ditch, and one in a canal. Habitats can include damp mud flats and bodies of water with fluctuations in water level (Baker 1911, Jokinen 1983).

Chemical parameters for the eleven sites were: pH: 6.4-8.3 (7.1 ± 0.2), conductivity: 75-863 µmhos/cm (265 ± 65), Ca^{++}: 5-35 ppm (13 ± 3), and Na^{+}: 1-43 ppm (12 ± 4). Connecticut data are limited and come from a mill pond that had great fluctuations in water levels. The pond had the following chemical values indicative of soft water: pH: 6.3, conductivity: 98 µmhos/cm, Ca^{++}: 3 ppm, and Na^{+}: 8 ppm (Jokinen 1983).

Fossaria obrussa (Say, 1825)

Golden fossaria
Fig. 16h, 18

Shell subconical, 13 mm high, pointed, oblong, thin, frequently inflated, light yellowish tan to black; umbilicus distinctly open to scarcely observable; spire acute, sharply conical; shell with sculpture of fine spiral lines, sometimes malleated; apex with 1.3 nuclear whorls; whorls 5-6, rounded, shouldered near suture; body whorl large, 0.5 times length of shell, usually compressed, sometimes obese; sutures deeply indented; aperture elongate-oval; outer lip thin, acute; inner lip reflected over umbilical chink to form a thin, narrow expansion appressed to umbilical region, giving axis a slight twist; callus thin (Baker 1928a).

This species occurs from the Atlantic to the Pacific Ocean, and from Canada south to Arizona and northern Mexico. It is present but rare in Upper Michigan (Baker 1928a, Richards 1934, Goodrich & van der Schalie 1939).

Twenty-one sites studied during this survey had populations of *F. obrussa*: Hudson River watershed (302, 368, 452, 589); Mississippi-Ohio River watershed (420, 422, 424); St. Lawrence River watershed (141B, 279, 308, 311, 332, 337, 345, 350, 371, 396, 405, 411, 440); and the Susquehanna River watershed (399).

Fossaria obrussa (called *Lymnaea decidiosa* Beck in some of the early literature) has been known to occur in New York State since De Kay (1843) reported it "from various parts of the state, in rivulets and small lakes." It also was reported from Herkimer and Otsego Counties (Lewis 1856b, 1860, 1872, 1874); Staten Island, Richmond County (Hubbard & Smith 1865); New York City (Prime 1880); Onondaga County (Beauchamp 1886b); Monroe County (Walton 1891); the Albany/Troy area, Albany and Rensselaer Counties, and Litchfield, Herkimer County (Marshall 1894, 1895); Erie Canal "Wide-waters" at Rochester, and from Irondequoit Bay, Lake Ontario, Monroe County (Baker 1900b); Cazenovia Lake, Madison County (Henderson 1907); Huntington, Suffolk County; Flushing, Queens County, Long Island (Wheat 1907a); Rose Hill, Squaw Island, Erie Canal, Lime Lake in Cattaraugus County, Muddy Creek in Buffalo, Erie County (Letson 1909); Wyoming County (Baker 1913); Sodus Bay in Lake Ontario, Wayne County (Burdick 1939); and in Adirondack State Park, Warren County (Jacobson 1945).

Harman & Berg (1971) followed the taxonomy of Hubendick (1951) and lumped all the *Fossaria* group into one species, *Lymnaea humilis* (Say, 1822). Burch (1982) distinguished the *Fossaria* as consisting of more than one species, and places *F. exigua, F. modicella, F. obrussa, F. peninsulae*, and *F. rustica* in a *F. obrussa* group.

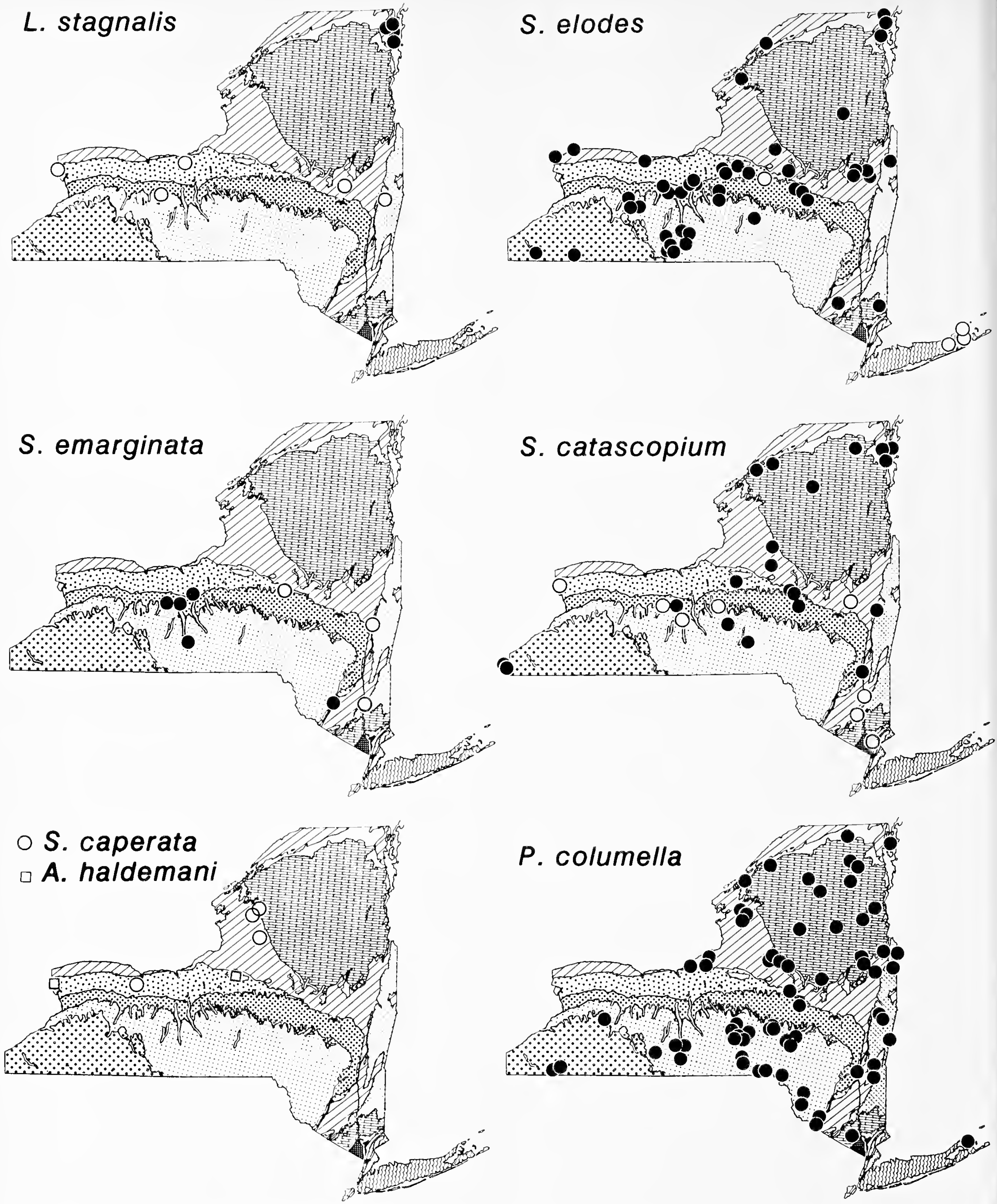


Fig. 17. Known distributions of species of Lymnaeidae in New York State. Closed symbols indicate records from the present survey, and open symbols indicate records from museum specimens.

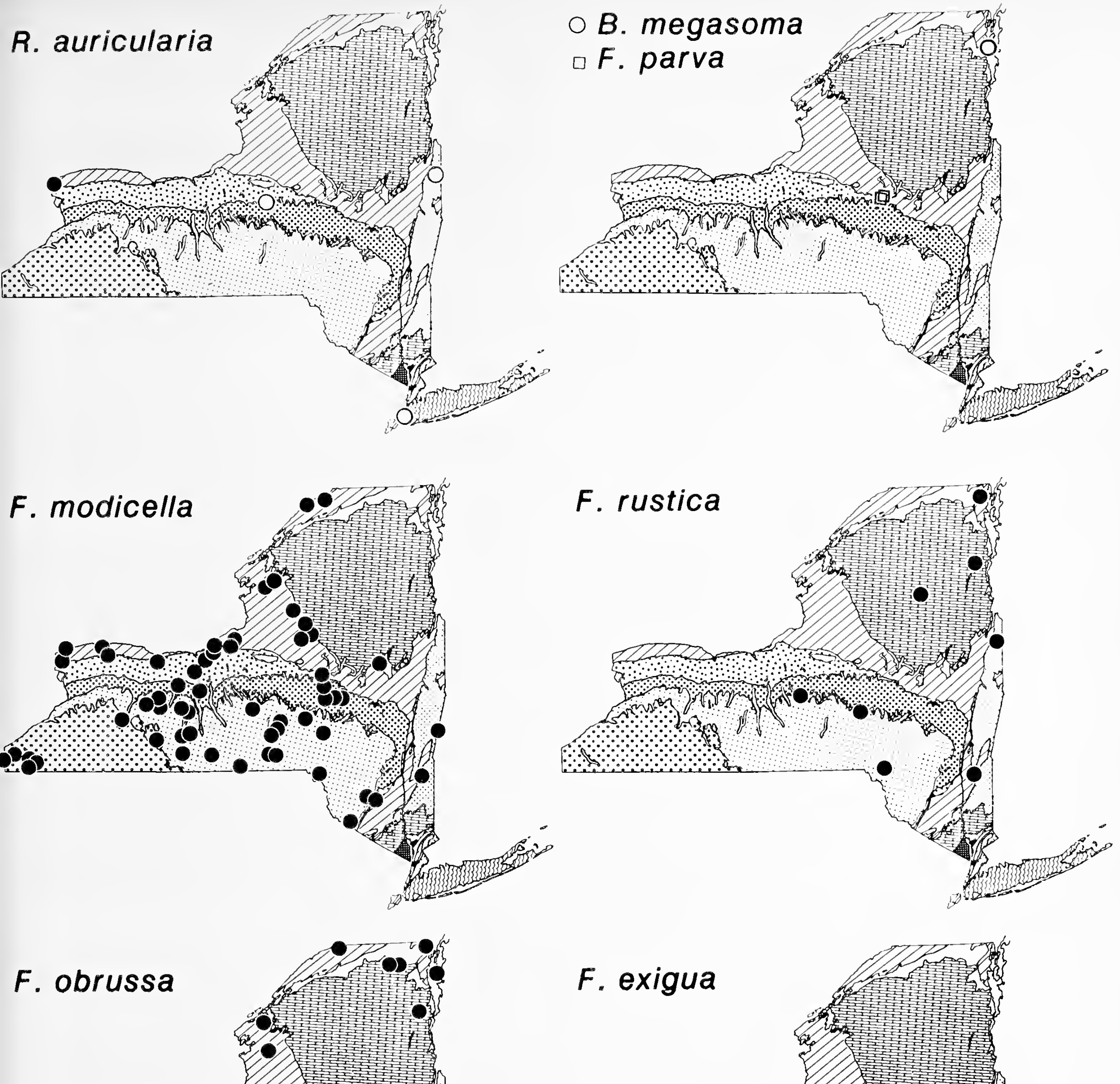


Fig. 18. Known distributions of species of Lymnaeidae in New York State. Closed circles indicate records from the present survey, and open circles indicate records from museum specimens.

During the present survey, *F. obrussa* was found in eight river and stream sites, four lakes, eight ponds, and one canal. In other areas of the country, this species lives in lakes; creeks; ponds; sloughs; bays; muddy, marshy areas along river banks; and intermittent small and large streams (Baker 1928a, Goodrich & van der Schalie 1939, Dawley 1947, Cvancara 1983). The snails are difficult to see in the field because of mud covering their shells (Goodrich 1932).

Chemical value for 20 sites were: pH: 6.5-7.8 (7.3 ± 0.1), conductivity: 64-1755 μmhos/cm (397 ± 84), Ca^{++}: 1-56 ppm (24 ± 4), and Na^{+}: 1-193 (26 ± 10).

Fossaria exigua (I. Lea, 1841)

Graceful fossaria
Figs. 16i, 18

Shell turreted, 9 mm high, subfusiform, generally narrow, brown; umbilicus small, narrow, or covered by inner lip; spire wide, elevated, turreted, slowly increasing in diameter, generally longer than aperture; whorls 5.0, well-rounded, slowly increasing in diameter; body whorl flattened, subcylindrical, 2/3 length of shell; sutures deeply impressed; aperture ovate, slightly flared at base; outer lip thin; inner lip slightly reflected with lower part nearly straight (Baker 1928a; Clarke 1973, 1981).

This species occurs from Maine west to Iowa and Minnesota, north to Hudson Bay, and south to Alabama (Baker 1928a, Nylander 1943, Clarke 1973).

Seven sites in New York yielded specimens of *F. exigua* during this survey: Mississippi-Ohio River watershed (415, 432); St. Lawrence River watershed (449); and Susquehanna River watershed (388, 552, 553, 591).

The only reference to *F. exigua* in New York is from the Black River drainage in Lewis and Oneida Counties (Buckley 1977).

New York habitats sampled during this survey included four river and stream sites, one lake, and one pond. This species is rare in New York State and Connecticut. In Connecticut, it was found in a cool inlet side of a small pond formed by road fill. Egg masses and immatures appeared in early June (Jokinen 1983). In Canada, *F. exigua* lives in lakes, subarctic muskeg, and slowly flowing sections of rivers (Clarke 1973). It can also inhabit bayous, small ponds, ditches and mud flats (Baker 1928a).

Chemical parameters for five of the New York sites are: pH: 6.8-7.7 (7.2 ± 0.2), conductivity: 191-284 μmhos/cm (237 ± 15); Ca^{++}: 4-25 ppm (12 ± 5), and Na^{+}: 1-12 ppm (7 ± 2). The single Connecticut population, living in a stream inlet near a pond, existed in water with chemistry parameters of pH: 6.4, Ca^{++}: 12 ppm, and Na^{+}: 10 ppm (Jokinen 1983).

Family Physidae

Shell sinistral, oval, elongate or globular, imperforate, thin to thick; spire short to elongate; sculpture smooth or with well-developed spiral lines; animal sinistral, with excretory and genital orifices on left; jaw single, arched; radula with teeth in oblique rows; lateral teeth comblike (Fig. 5c); form of penial complex diagnostic for genera and subgenera (De Kay 1843; Baker 1928a; Clampitt 1970; Te 1975).

Burch (1989) places most of the *Physa* species in the genus *Physella*.

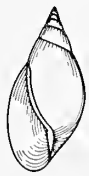
Key to the Physidae

Physids are difficult to identify because of highly variable shell structure and general similarity among species. A major advance in identifying these species involves inspection of the shape of the penial apparatus, which is internal in a non-everted state.

To remove the male reproductive system in physids, first remove the snail from its shell (do not destroy the shell) and lay it on its right side in a small dish (Fig. 19a). The body should be covered with preservative. Carefully cut or rip the epidermis middorsally from the head to the beginning of the mantle. Pull back the skin. The male reproductive tract will be visible just behind the left tentacle (see Fig. 19b). Gently uncoil the vas deferens and pull the penial apparatus straight. It will be secured by tiny muscles that might have to be cut if they have not pulled apart. Figs. 19c and d illustrate the anatomy. If it appears that the normally obvious reproductive system is dwarfed or obliterated, the snail is probably infected with parasitic trematode larvae, which can cause castration. To measure the various regions of the penial apparatus accurately, the system will have to be removed from the snail at the male reproductive pore, placed on a slide, and examined with a microscope.

1a. Shell aperture approximately same length as spire.....2

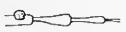
1b. Shell aperture longer than spire....................................3



2a. Aperture base somewhat truncated; preputial gland present...*Physa vernalis*

2b. Aperture base rounded; preputial gland absent ....
....*Aplexa elongata*

3a. Penial sheath in two sections; shell sutures deep 4



3b. Penial sheath in one section; shell sutures shallow 5

4a. Outer lip of shell bordered by strong white varix, occasionally with a purple line on inner side; shell usually pale tan in color .... *Physa integra*

4b. Outer lip of shell bordered by purple varix; shell usually dark in color .... *Physa heterostropha*

5a. Spire very short; outer whorl shouldered in adults .... *Physa ancillaria*

5b. Spire moderate in length; outer whorl not shouldered .... *Physa gyrina*

Aplexa elongata (Say, 1821)

Lance aplexa

Figs. 20a, 21

Shell elongate, thin, transparent, polished, oily in appearance, light brown, up to 20 mm high; spire long, pointed, acute, 0.5 times shell length; apex large, flatly rounded, partly embraced by second whorl below which nucleus is sunken; whorls 6.0, rounded; body whorl long, narrow, compressed; sutures well-impressed, bordered below by narrow white zone; aperture 0.5 times shell length, narrowly elongate; outer lip thin; columella oblique, narrow, slightly twisted; callus a thin wash on parietal wall. Mantle without digitations, not reflected over shell; penial gland absent (Baker 1928a, Te 1975).

This species closely resembles the European *A. hypnorum* (L.), with which it has been confused in the past.

A. elongata occurs from the District of Columbia north to James Bay and arctic Alaska and south to Idaho (Goodrich & van der Schalie 1939; Dawley 1947; Clarke 1973, 1981; Cvancara 1983; Burch 1989).

Only two populations of *A. elongata* were found during this survey. They were in Dead Creek, Plattsburgh, St. Lawrence River drainage (259B) and an unnamed stream and vernal pond in Wallkill Township, Hudson River watershed (451). Strayer (1987) did not locate populations in the lower Hudson River watershed but notes that numerous museum records indicate its presence. This species' habitats were undersampled during this study.

There are numerous literature references to this species in New York. Early accounts are from Otsego and Herkimer Counties (Lewis 1856b, 1860, 1872); Onondaga County (Beauchamp 1886b); Pittsford, Monroe County (Walton 1891, Marshall 1894); Albany/Troy area, Albany and Rensselaer Counties (Marshall 1895); a marsh at the foot of Owasco Lake, Cayuga County (Baker 1899); Cazenovia Lake, Madison County (Henderson 1907); Huntington, Suffolk County, Long Island (Wheat 1907a); and Niagara and Erie Counties (Letson 1909). More recent accounts are from pools near Quaker Run, Allegany State Park, Cattaraugus County (Pinney & Coker 1934); Adirondack State Park, Warren County (Jacobson 1945); the Finger Lakes region of Oswego watershed (Harman & Berg 1971); Otsego County (MacNamara & Harman 1975); and Jefferson County (Buckley 1977). Specimen lots at the Museum of Comparative Zoology are from Baldswinsville, Onondaga County; Buffalo, Erie County; Mohawk and Frankfort, Herkimer County; and Cazenovia, Madison County. Specimens deposited in the American Museum of Natural History are from Wyoming County and Staten Island, Richmond County.

Aplexa elongata is an inhabitant of temporary pools, ditches, swampy meadows, bayous, marsh pools, swales, intermittent streams, and, less frequently, permanent ponds and lake shallows (Baker 1928a; Goodrich 1932; Dawley 1947; Harman & Berg 1971; Clarke 1973, 1981; Cvancara 1983). Sediments in these habitats range from mud to sand (Cvancara 1983), usually with decaying terrestrial plant litter (Archer 1939, Harman 1972). The snail is a detritivore (Brown 1982).

This species usually occurs in hard water. In North Dakota, Cvancara (1983) reported a habitat pH range of 7.8-8.9 and conductivity of 293-3900 µmhos/cm. Surveys in Southern Ontario showed the species reached its maximum shell size in hard water (McKillop & Harrison 1972). At 17 sites in central New York, pH values were 6.8-8.1 (Harman & Berg 1971). In this study, the two habitats of *A. elongata* had pH: 6.8, 8.1; conductivity: 212, 371 µmhos/cm; Ca^{++}: 13, 44 ppm; and Na^{+}: 10, 18 ppm.

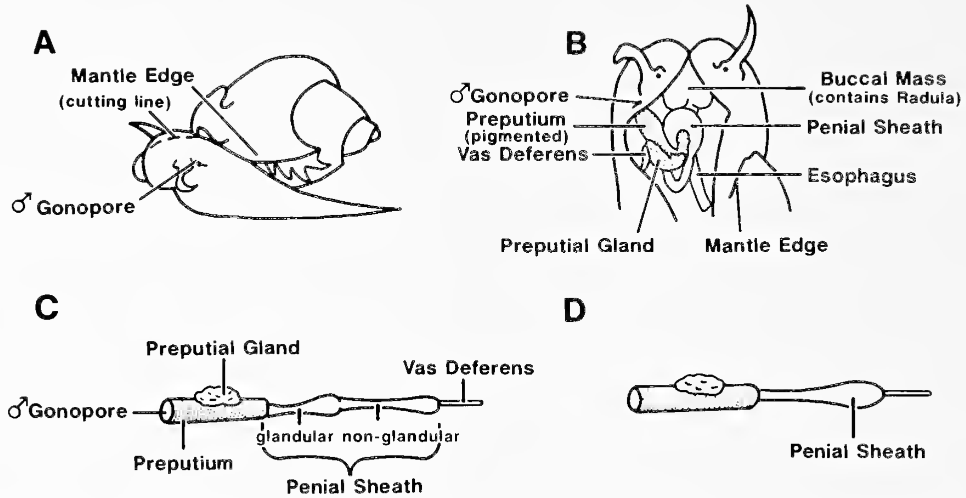


Fig. 19. Family Physidae, internal anatomy: a, body with shell removed, illustrating position of male gonopore; b, dissected head end in dorsal view, illustrating position of penial complex, dorsal view; c, penial complex with two-part sheath; d, penial complex with simple sheath (from Jokinen 1983).

Physa vernalis Taylor & Jokinen, 1984

Springtime physa

Figs. 20b, 21

Shell ovoid-fusiform, 11 mm high, thin, pale brown, silky to shiny; apex blunt; whorls 5.0-6.0, weakly convex; suture shallow, broadly attached; aperture elongate-oval, rounded anteriorly, acute posteriorly, widest at mid length; outer lip thin, sharp; columellar lip a rounded ridge forming a low plait as it enters whorl cavity; callus thin, white, closely appressed to parietal wall; male reproductive system with penial sac swollen proximally; mantle margin barely expanded over shell margin, with two groups of digitate projections (Taylor & Jokinen 1984).

The confirmed distribution includes Massachusetts, Connecticut, Rhode Island, New York, and probably Ohio, Michigan, and Canada (Taylor & Jokinen 1984). The shells of this species strongly resemble young of *Aplexa elongata*, and further examination of museum specimens might yield misidentified specimens of *P. vernalis*.

Two live populations of this species were found in New York. These were at Lake Conesus inlet, St. Lawrence River watershed (507) and a marshy tributary of Otselic Creek, Susquehanna River watershed (555). Strayer (1987) found one specimen in the Hudson River watershed, Dutchess County. One lot in the Museum of Comparative Zoology (MCZ 193794), originally identified as *Aplexa hypnorum*, is from Madison, Madison County.

Physa vernalis inhabits streams, ditches, temporary and permanent ponds, and shallows of lakes (Taylor & Jokinen 1984; this study). Although the snails graze diatoms in early spring and filamentous green algae in late spring and summer, their primary food source is detritus (Kesler *et al.* 1986). Field population numbers and differential survival of larger individuals are controlled in part by predation (Kesler & Munns 1989).

Little is known of the chemical parameters under which this species exists. In the region of eastern Connecticut where the first populations were described, the waters are soft. At twelve sites described in Taylor & Jokinen (1984), pH values were 5.9-7.1, conductivity: 31-283 µmhos/cm, Ca^{++}: 2-12 ppm, and Na^{+}: 3-30 ppm. A pond in Rhode Island had pH < 5.8 (Kesler *et al.* 1986). The two sites in New York had water chemistry values of pH: 6.5, 7.8; conductivity: 31, 283 µmhos/cm, Ca^{++}: 4, 28 ppm, and Na^{+}: 20, 24 ppm. It appears that *P. vernalis* can live in soft to hard waters.

Physa heterostropha (Say, 1817)

Pewter physa

Figs. 20c, 21

Shell cylindrical, sometimes inflated, 16 mm high, thin, translucent, surface smooth and shining, yellow-tan to chestnut; spire moderately long, acute, pointed; nucleus small, yellowish to slightly reddish, well-exerted above second whorl; whorls 5.0-6.0; body whorl large, compressed or flatly rounded; sutures impressed; aperture 2/3-4/5 shell length, tan with red-bordered varix; outer lip thin, flattened, slightly shouldered above, broadly rounded below; columella slightly oblique, thickened, not twisted; callus a thin wash on parietal wall (Baker 1928a); male penial sheath of one section, approximately equal in length to preputium (Fig. 20c) (Te 1975, Jokinen 1983).

This species occurs from the Atlantic provinces of Canada south to Ohio, Kentucky, Tennessee, Florida, and the

Bahama Islands (Clarke 1981; Jokinen 1983; Blair & Sickel 1986; Branson 1987; Burch 1989). The southern subspecies, *P. heterostropha pomilia* (Conrad), occurs throughout Florida.

P. heterostropha is common throughout New York, and it was found in the Delaware River watershed (455, 456, 468, 470); Hudson River watershed (96E, 96G, 96H, 265, 266, 268, 269, 274, 286, 287, 288, 289, 292, 293, 299, 320, 368, 379, 451, 452, 588, 589, 604, 613, 616); Ohio-Mississippi River watershed (420, 427A); St. Lawrence River watershed (262, 307, 312, 314, 315, 332, 334, 335, 336, 338, 339, 341, 342, 343, 344, 377, 390, 392, 393, 394, 395, 396, 397, 398, 401, 403, 405, 407, 408, 410, 433, 439, 440, 441, 445A, 445B, 445C, 448A, 448B, 493, 495, 496, 497, 507, 508, 509, 513, 519, 520, 521, 523, 525, 528, 533, 535, 559, 560, 561, 562, 565, 566); Susquehanna River watershed (388, 391, 399, 477, 537, 538, 540, 542, 544, 545, 547, 549, 550, 551, 553, 554, 558, 567, 570, 573, 577, 580, 593); Housatonic River watershed (294); Hackensack River watershed (605, 606); and Atlantic coastal streams and ponds (253, 322). Harman & Berg (1971) found *P. heterostropha* to be common in central New York, and Strayer (1987) found it to be the most abundant physid in the lower Hudson River watershed.

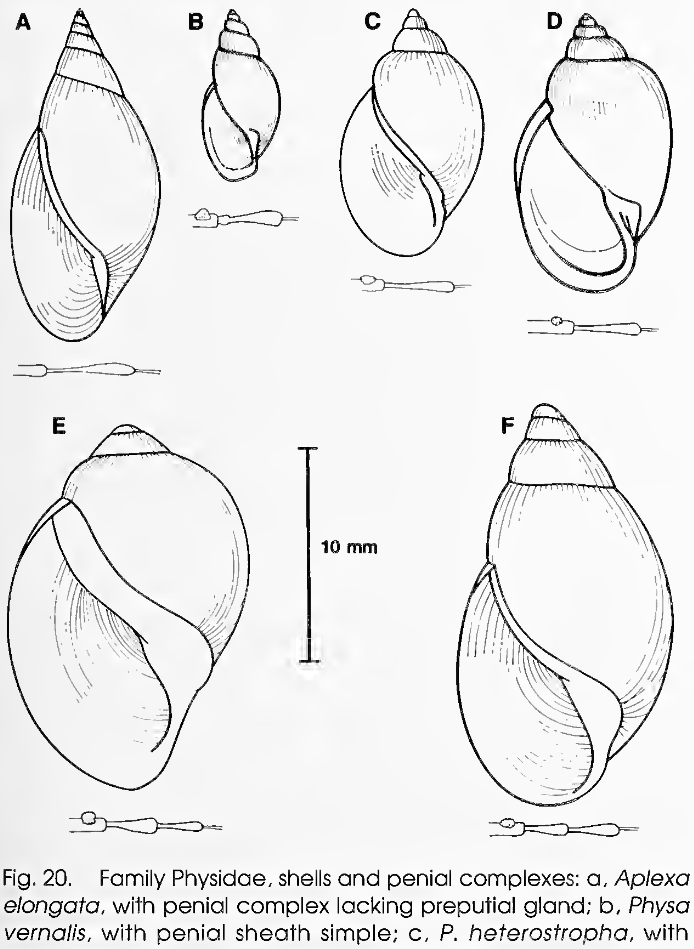


Fig. 20. Family Physidae, shells and penial complexes: a, *Aplexa elongata*, with penial complex lacking preputial gland; b, *Physa vernalis*, with penial sheath simple; c, *P. heterostropha*, with penial sheath simple; d, *P. integra*, with penial sheath simple; e, *P. ancillaria*, with penial sheath in two parts; f, *P. gyrina*, with penial sheath in two parts. All shell illustrations are drawn to the same scale.

There is extensive literature on this species in New York State. De Kay (1843) listed the species as "very common...in almost every pond and running stream." He specifically recorded it from Red Creek, Wayne County (as *P. cylindrica*); New York island (as *P. plicata De Kag*); and West Point, Orange County (as *P. aurea* Lea). Other 19th century authors recorded the species from Herkimer and Otsego Counties (Lewis 1856b, 1860, 1872); Staten Island, Richmond County (Hubbard & Smith 1865, Marshall 1894); Riverdale, Bronx County (Prime 1880); Onondaga County (Beauchamp 1886b); the Erie Canal (Baily 1891); Rochester, Monroe County (Walton 1891); Glen Cove, Nassau County, Long Island; Litchfield, Herkimer County; Pittsford, Monroe County (Marshall 1894); Albany/Troy area, Albany and Rensselaer Counties (Marshall 1895); Hudson River tide-creeks and marshes (Mearns 1898); Chautauqua Lake, Chautauqua County (Maury 1898); Canandaigua Lake, Ontario and Yates Counties (Mitchell 1899); Owasco River, Cayuga County (Baker 1899); and the Erie Canal "Widewaters" in Rochester, the Genesee River, and Irondequoit Bay in Lake Ontario, all in Monroe County (Baker 1900b, 1901).

Early 20th century reports record *P. heterostropha* from Cazenovia Lake, Madison County (Henderson 1907); Long Island (Wheat 1907a); Erie and Niagara Counties (Letson 1909); and the Oneida Lake region (Baker 1918a). Later reports are from Allegany State Park, Cattaraugus County (Pinney & Coker 1934); Bronx River at the south end of Bronx Park, Bronx County; stream in Brooklyn Botanic Gardens, Kings County; Forest Park Pond, Queens County (Freas 1950a); Upper Ferdun Pond, Rockland County (Bretet & Carswell 1952); Oakland Lake, Queens County, Long Island (Jacobson 1965); Crystal Brook, Mount Sinai, Suffolk County, Long Island (Jacobson 1969); Green Lake, Onondaga County (Harman 1970); Cayuga Lake, Seneca and Cayuga Counties; Oneida Lake, Oswego and Madison Counties; Green and Round Lakes, Onondaga County; Panther Lake, Oswego County; DeRuyter Lake, Madison County (Harman & Berg 1971); and Otsego Lake, Moe Pond, and New Pond, Otsego County (MacNamara & Harman 1975).

Physa heterostropha is abundant and ubiquitous in its habitats. The 121 sites found during this survey include 49 rivers and streams, 30 lakes, 24 permanent ponds, two temporary ponds, seven ditches, three marshes, and six canals. The breadth of potential habitats is similar in Connecticut (Jokinen 1983), Kentucky (Blair & Sickel 1986, Branson *et al.* 1987), and eastern Canada (Clarke 1981). The snails are most often found on silt and detrital substrata (Harman 1972). The species has a good dispersal rate, good colonization ability, and broad habitat tolerance (Jokinen 1987). However, it cannot colonize high altitude habitats (Jokinen 1991).

This species also demonstrates a wide range of chemical tolerance. Water chemistry data from 111 sites found during this study are: pH: 6.0-8.8 (7.3 ± 0.1), conductivity: 39-2320 μmhos/cm (382 ± 28), Ca^{++}: 1-89 ppm (23 ± 2), and Na^{+}: 1-291 ppm (29 ± 4). Chemical data from Connecticut sites were: pH: 6-10, conductivity: 24-387 μmhos/cm, Ca^{++}: 1-35, and Na^{+}: 1-22 ppm. At Harman & Berg's (1971) 79 central New York sites, pH values were 6.8-8.5 (mean = 7.7). Baily (1929) noted this species to exist at 50% salinity in the Gunpowder Estuary of Chesapeake Bay. The water chemistry values indicate wide tolerance to low calcium and high sodium concentrations.

Physa integra Haldeman, 1841

Ashy physa
Figs. 20d, 21

Shell elongate-ovate, 17 mm high, thick, solid, white to yellow to tan, usually dull; spire wide; nucleus small, rounded, light brown with one whorl; whorls 5.0, rounded; body whorl large, a little shouldered; sutures deeply impressed; aperture ear-shaped, angled above, well-rounded below, 60-70% of shell length; outer lip thickened, with heavy, white varix; varix often edged by brown streak; up to 7 white streaks representing former lip varices visible through shell; columella oblique, thick, inner lip folding over into umbilical region to form wide, flat expansion continuous with outer lip, sometimes with plait-like ridge; callus on parietal wall thin to thick; penial sheath simple, approximately same length as preputium (Baker1928a, Te 1975).

The anatomy of *P. integra* is discussed in Baker (1928a) and Clampitt (1970).

This species occurs from Quebec west to Manitoba, and south to the Dakotas, Iowa, Tennessee, Kentucky, and West Virginia (Goodrich 1932, Goodrich & van der Schalie 1939, Dawley 1947, Clarke 1981, Branson 1987, Blair and Sickle 1986, Burch 1989). It is absent from southern New England (Jokinen 1983).

Physa integra was found in all major New York watersheds except the Delaware River watershed. During this study, populations were found in the Hudson River watershed (453, 596, 600, 608, 609, 614); Ohio-Mississippi River watershed (416, 417, 423, 424, 426, 427B, 428, 429, 430A, 431); St. Lawrence River watershed (345, 390, 406, 409, 412, 436, 437, 438, 439, 442, 445A, 445B, 449, 450, 498, 499, 501, 502B, 503, 504, 505, 506, 511, 512, 515, 516, 517, 518A, 518B, 521, 522, 524B, 525, 526, 529, 530, 531, 563, 564); and Susquehanna River watershed (389, 400, 552, 578, 581, 586, 591, 592, 595). The majority of sites were in central and western New York. These observations agree with those of Harman & Berg (1971), who found the species to be the most common physid in central New York (Oswego-St. Lawrence River and Susquehanna River watersheds), and with those of Strayer (1987), who found no living populations in the lower Hudson River watershed.

Physa integra was first reported from New York, Herkimer, and Otsego Counties by De Kay (1843), who identified it tentatively. Later, Marshall (1894) recorded locations in Little Lakes, Herkimer County, and the Erie Canal. Additional sites were the Genesee River (Baker 1901); Cazenovia Lake, Madison County (Henderson 1907); Erie and Niagara Counties (Letson 1909); Oneida Lake, Oswego and Onondaga Counties (Baker 1916a, b; 1918a); Allegheny River, Riverside Junction, Allegany State Park, Cattaraugus County (Pinney & Coker 1934); Hudson River from Hudson, Columbia County, to Chelsea, Dutchess County (Townes 1936); Lake Ontario (Burdick 1939); and Conesus Lake, Livingston County (Wade & Vasey 1976).

This species lives in a variety of habitats, with streams and rivers being most common (Goodrich 1932, Dawley 1947, Cvancara 1983) except in southeastern Canada, where it is most common in lakes in either exposed or protected situations (Clarke 1981). During this survey, populations were found to occupy 30 river and stream sites, 16 lake sites, 11 permanent ponds, one temporary pond, five ditches, and three canals.

Substrata range from clay and mud to boulders (Baker 1928a, Clampitt 1970, Harman & Berg 1971, Clarke 1981, Cvancara 1983). Snails are also common on and in floating masses of algae and higher aquatic plants, such as *Ceratophyllum demersum* L., *Myriophyllum spicatum exalbescens* (Fern.) Jeps., *Ranunculus longirostris* Godr., and *Potamogeton* spp. (Clampitt 1970). Depths range from just beneath the inshore water surface to over 13 m, depending upon the depth limit of the rooted aquatic vegetation (Clampitt 1970, Harman & Berg 1971). In Douglas Lake, Michigan, populations overwintering in water greater than 2 m deep migrate toward the cobble shore in late April and early May, where they spawn and die. In September, the new generation migrates into deep water to overwinter (Clampitt 1974).

Several studies have been done on *P. integra*, and life history and ecological details differ with geographic location. Life cycles have been described as univoltine for a backwater in New York (Eckblad 1973), bivoltine in an Iowa lake (Clampitt 1970), and multivoltine in an Iowa intermittent stream (Brown 1979). The snails begin to lay eggs when their shells reach 5 mm in height, about two to three months after hatching. The number of eggs deposited varies from 200-540 eggs/snail/month. Clutches contain 18-31 eggs (Clampitt 1970, Brown 1979).

Food consists of detritus, diatoms, and filamentous green and blue-green algae with some animal parts and vascular plant tissue. Relative proportions of food types depend on season. Sand grains are present in the gut (Clampitt 1970, Eckblad 1973). Dispersion in the field was relatively even in a backwater (Eckblad 1973) but clumped in an intermittent stream (Brown 1979). The life history pattern of the latter population was relatively insensitive to temperature changes (Brown 1979). In a lake

population, the snails could not survive high summer temperatures, and they stayed in deeper, cooler water offshore. In winter, the snails were abundant on *Ceratophyllum* sp. (Clampitt 1970). Shell growth occurred in summer with little or no shell deposition over winter months (Clampitt 1970, Eckblad 1973).

Clampitt (1970) and Brown (1979) regarded these differences as adaptive for lake and intermittent stream populations, respectively. Adaptations to ephemeral habitats included reproduction at an earlier age, a shorter life cycle, more generations per year, and insensitivity to temperature (Brown 1979). Adaptations for lake populations were slower growth rates and a longer period of reproduction (Clampitt 1970).

For 61 New York collection sites, the water chemistry values are: pH: 6.0-9.7 (7.4 ± 0.1), conductivity 64-1240 μmhos/cm (431 ± 33), Ca^{++}: 3-70 ppm (26 ± 2), and Na^{+}: 1-144 ppm (29 ± 4).

In North Dakota, Cvancara (1983) recorded values of pH: 7.9-9.3 (8.4), conductivity: 605-3600 μmhos/cm (1815), and Ca^{++}: 50-600 ppm (104). Sixteen Michigan sites (Hunter & Lull 1977) yielded values of conductivity: 105-2500 μmhos/cm, and Ca^{++}: 25-177 ppm.

Physa ancillaria Say, 1825

Pumpkin physa
Figs. 20e, 21

Shell cyclindrical, 20 mm high, greenish to tan to brown or red, thin to solid, shining; spire short, broad, obtuse; whorls slanting at 45° angle; nuclear whorl small, reddish; whorls 4.5-5.0, somewhat compressed, flat sided; body whorl strongly shouldered, large; sutures scarcely impressed; aperture large, 70-80% of shell length, purplish or liver colored inside; outer lip compressed and flattened, distinctly shouldered; columella straight with distinct plait (Baker 1928a). *Penial sheath in 2 sections* (Fig. 20e)*; nonglandular section narrower and/or shorter than glandular section* (Jokinen 1983).

This species occurs in New Brunswick, Ontario, New York, Pennsylvania, and New England (Burch 1982).

Physa ancillaria was found at the following sites during this survey: Delaware River watershed (456, 457, 458, 462, 470, 471); Hudson River watershed (96C, 96F, 270, 276, 297, 319, 384, 455, 459B, 461, 603, 604); St. Lawrence River watershed (141A, 141B, 259B, 306, 313, 332, 346, 361, 437); and the Susquehanna River watershed (569, 571, 572). Most sites are in the eastern part of the State, with a few toward the central portion and one western. Harman & Berg (1971) found only one living specimen in central New York. Strayer (1987) found *P. ancillaria* to be the most common physid along the margins of the lower Hudson River.

The literature on this species indicates that it occurs across New York State. Early citations include the Mohawk and Hoosic Rivers, Rensselaer County (as *P. obesa* DeKay), and Lake Champlain, Clinton County (De Kay 1843); rivers of Herkimer County (rare) (Lewis 1860); Owasco Lake, Cayuga County (Lewis 1874, Maury 1916); Skaneateles Lake, Onondaga County (Beauchamp 1886b); Rochester, Monroe County (Walton 1891); Greenbush Lake, Rensselaer County (Marshall 1894); Albany/Troy area, Albany and Renssalaer Counties (Marshall 1895); Hudson River brackish marshes (Mearns 1898); Chautauqua Lake, Chautauqua County (Maury 1898, 1916; Evermann & Goldsborough 1901); Canandaigua Lake, Ontario/Yates County (Mitchell 1899); a marsh at the foot of Owasco Lake (Baker 1899); and Oneida Lake, Oswego and Onondaga Counties (Baker 1916a, b; Pratt 1923). Scarcity of recent reports could be due to the resemblance of immature *P. ancillaria* to immature *P. gyrina*. The male reproductive systems of the two species are similar, and immature *P. ancillaria* have not yet acquired the large, shouldered body whorl typical of the species (Jokinen, unpublished data).

This species can be found on substrata of allochthonous organic material, rocks, and decaying aquatic vegetation (Jokinen 1983). During this survey of New York State, *P. ancillaria* was located in 15 river and stream sites, nine lake sites, four permanent ponds, a temporary pond, and three canals. In Connecticut, habitats include permanent ponds and lakes with surface areas of 10-100 hectares and the Connecticut River (Jokinen 1983). *P. ancillaria* is found in most species-rich habitats but rarely in species-poor habitats (Jokinen 1987). In New York, it is able to migrate into high altitude habitats (Jokinen 1991).

An annual study of this species in a Connecticut lake indicated that there was a pattern of continuous juvenile recruitment throughout the summer. The population overwintered as a mixture of newly hatched and larger individuals up to 18 mm long. The larger snails deposited egg masses in April when the water temperature rose to 8.5°C, and then they died. The eggs hatched from mid May through mid June. By mid June, the earliest spring hatchlings and the overwintered immatures from the previous fall were large enough to deposit another generation of eggs. Newly hatched young appeared in the population until late October (Jokinen 1985). It appears that *P. ancillaria* is bivoltine or, possibly, trivoltine.

Chemistry data for 28 New York sites are: pH: 5.8-9.2 (7.3 ± 0.1), conductivity: 46-400 μmhos/cm (172 ± 18), Ca^{++}: 1-44 ppm (12 ± 2), and Na^{+}: 1-62 ppm (10 ± 1). In Connecticut, the ranges were: pH: 5.8-8.9, conductivity: 39-286 μmhos/cm, Ca^{++}: 2-21 ppm, and Na^{+}: 2-29 ppm (Jokinen 1983). *P. ancillaria* has a wide range of chemical tolerance, occurring in habitats with wide ranges of pH and calcium concentration.

Physa gyrina (Say, 1821)

Tadpole physa
Figs. 20f, 21

Shell subcylindrical, moderately elongated, 24 mm high, thin to slightly thickened, pale yellow-brown to grey-brown; spire short to long, acute; nuclear whorl small, red to reddish-brown; whorls 5-6, gently rounded, each partly enveloping preceding whorl; body whorl large, well-rounded, compressed to slightly inflated; sutures impressed, bordered below by narrow pale band; aperture loop-shaped, acute above, rounded at base, 60-80% of shell length, bordered inside by red band; outer lip thin to slightly thickened; columella oblique, thin to thickened; parietal wall callus a thin to thick, extensive wash (Baker 1928a, Clarke 1973). *Elongated penial sheath of two somewhat equal sections separated by prominent constriction* (Clampitt 1970).

The morphology of this species is discussed by Clampitt (1970).

Physa gyrina occurs from the Gulf of Mexico north to James Bay and drainage basins, west to California (Clarke 1973, Taylor 1981).

This species occupies all the major drainage areas of New York: Delaware River watershed (469, 472, 475); Hudson River watershed (271, 290, 300, 302, 317, 367, 382, 460, 587); Ohio-Mississippi River watershed (415, 421, 422, 432); St. Lawrence River watershed (141A, 141D, 259A, 259B, 279, 308, 309, 311, 316, 331, 333, 337, 340, 347, 349, 350, 351, 360, 366, 371, 373, 374, 375, 376, 396, 438, 441, 443, 444, 445A, 448B, 450, 493, 494, 502A, 516, 524A, 524B, 526, 527, 529, 530, 532, 563, 566); Susquehanna River watershed (389, 539, 541, 546, 548, 574, 575, 576, 578, 582, 583, 590, 591); and coastal Atlantic (250). Strayer (1987) reports it to be very common in the upland lakes and streams of the lower Hudson River valley. The species, with its subspecies *P. g. sayii* Tappan and *P. g. elliptica* Lea, is widely distributed throughout central New York (Harman & Berg 1971).

The historical literature contains numerous references to *P. gyrina* and the subspecies *P. g. sayii*, *P. g. elliptica*, and *P. g. hilderanthiana* (Lea). De Kay (1843) and Lewis (1874) note that it exists in various parts of the State. Other early references are for Onondaga County (Beauchamp 1886b); Erie Canal, Monroe County (Walton 1891); Baldwinsville, Onondaga County (Marshall 1894); the Genesee River (Baker 1901); Cazenovia Lake, Madison County (Henderson 1907); a number of sites near Buffalo, Erie and Niagara Counties (Letson 1909); near Warsaw, Wyoming County (Baker 1913); the west end of Oneida Lake, Oswego County (Baker 1916a, b); and Fall Creek, Ithaca, Tompkins County (Maury 1916). More recent references include collection sites at Allegany State Park, Cattaraugus County (Pinney & Coker 1934); Salmon Creek, Wayne County; Little Sodus Bay, Lake Ontario, Cayuga County (Burdick 1939); Six Mile Creek, Ithaca, Tompkins County (Ingram 1941); and Conesus Lake, Livingston County (Wade & Vasey 1976).

Habitats include intermittent and small, permanent streams, small rivers, temporary and permanent ponds, soft to hard water lakes, prairie lakes, river lakes, and large lakes (Dawley 1947, Clarke 1973, Cvancara 1983, Jokinen 1983). In New York, *P. gyrina* occupied the following habitats: 22 river and stream sites, 22 lake sites, 19 permanent ponds, a temporary pond, six ditches, seven canals, and a swamp. Silt and detritus are the most common substrata (Harman 1972).

The longevity of this species is approximately 260 days, and only 1-3% of individuals survive to reproductive maturity. In Minnesota, the snails are common prey for northern pike (*Esox lucius* (L.)), pumpkinseed sunfish (*Lepomis gibbosus* (L.)), bluegill sunfish (*L. macrochirus* (Rafinesque)), black crappie (*Pomoxis nigromaculatus* (Lesueur)), and yellow perch (*Perca flavescens* (Mitchill) (Sheldon 1987). If the snails survive predation, they follow a semelparous life history pattern, dying after having passed through only one reproductive period (Clampitt 1970, Brown 1979).

Physa gyrina consumes a general diet of detritus, periphyton, and carrion (Clampitt 1970, Brown 1982). The snails will crawl over macrophytes and graze vascular tissue as well as periphyton. The density of snail grazing can strongly influence the abundance and diversity of macrophytes. The snails tend to select for grazing the fast growing macrophytes such as *Potamogeton richardsonii* (Ar. Benn.) Rydb. and *P. zosteriformis* Fernald. Snails also can be found on *Ceratophyllum demersum* L. and *P. robbinsii* Oakes, but they do not cause extensive tissue damage (Sheldon 1987).

This species is bivoltine, producing two generations per year. Individuals of an overwintering population grow in early spring and deposit eggs in late spring. Unlike many other pulmonates, the egg-laying snails continue to grow for part of the summer and increase in fecundity as the shell lengthens. The young grow until late summer and deposit a second generation of eggs when their shells are about 7 mm long, at approximately five weeks old. The hatchlings of these eggs overwinter and begin to deposit eggs in the spring when they are approximately 37 weeks old (Clampitt 1970; Brown 1979, 1982). Fecundity ranges from 700-1617 eggs/snail or 50-135 eggs/week (Clampitt 1970, Brown 1979).

Physa gyrina can temporarily survive temperatures up to 40°C, and they can withstand relatively long periods of desiccation. These traits enable the snails to inhabit temporary ponds and the warm littoral edges of lakes (Clampitt 1970). When temperatures are increased from 21-26°C, the growth rate increases, and oviposition occurs earlier. In addition, total fecundity, shell length at death, and survival time beyond first oviposition increase. Shell size at first reproduction and clutch size remain the same (Brown 1979). Because of temperature differences, growth rates in ponds are greater than those in lakes (Clampitt 1970).

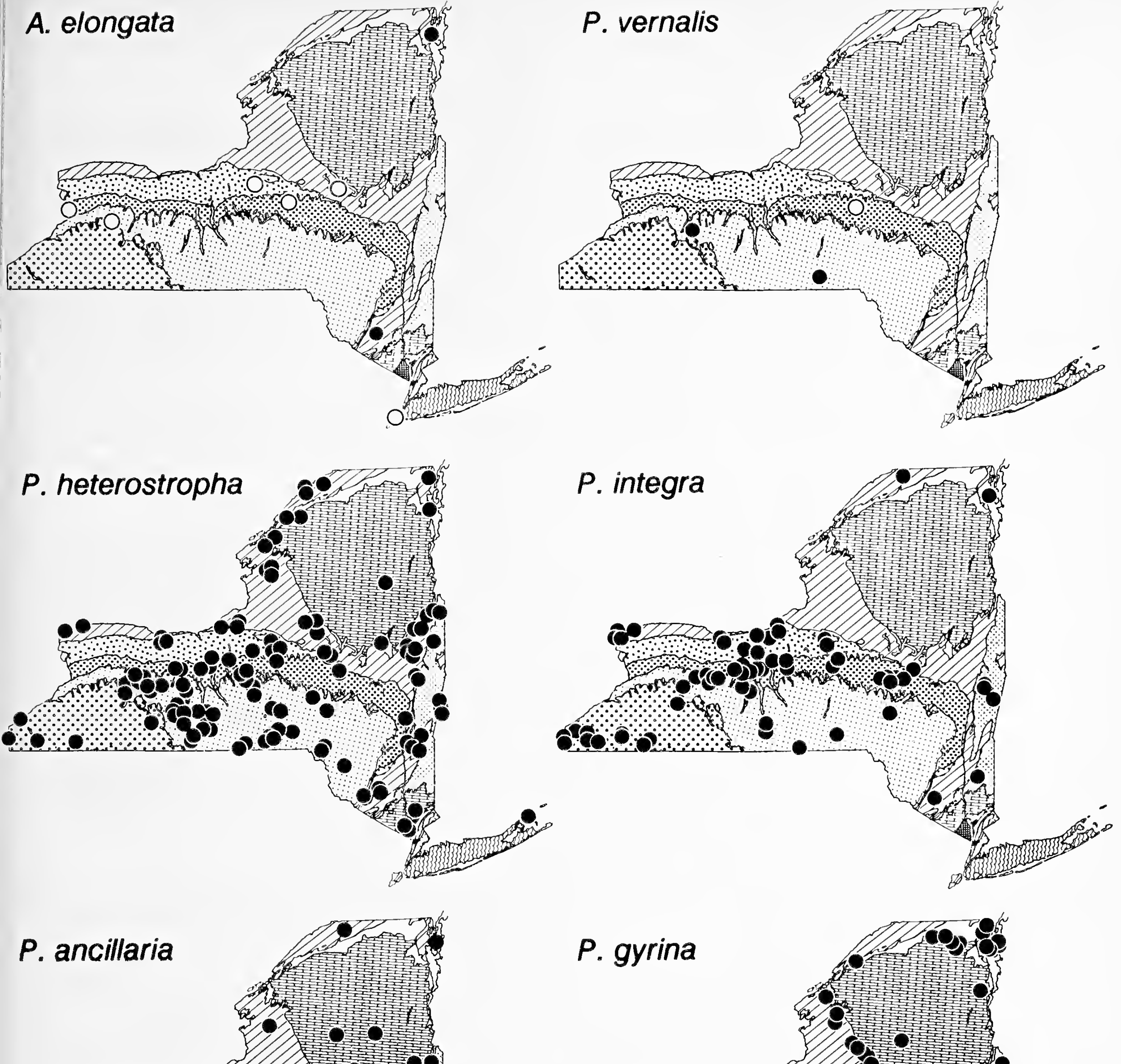


Fig. 21. Known distributions of species of Physidae in New York State. Closed circles indicate records from the present survey, and open circles indicate records from museum specimens.

Water chemistry values for 70 New York sites studied during this survey are: pH: 6.0-9.7 (7.3 ± 0.1), conductivity: 45-2320 μmhos/cm (364 ± 50), Ca^{++}: 1-94 ppm (21 ± 2), and Na^{+}: 1-291 ppm (24 ± 5). In Minnesota, *P. gyrina* tolerates a broad range of water hardness (Dawley 1947). In Connecticut, the snail was absent from highly organic and hard water habitats: pH: 5.7-7.2, conductivity: 40-148 μmhos/cm, Ca^{++}: 2-11 ppm, and Na^{+}: 2-11 ppm (Jokinen 1983). Cvancara's (1983) North Dakota values were: pH: 7.6-20.0 (8.6), conductivity: 300-8000 μmhos/cm (1480), and Ca^{++}: 30-360 ppm (159). In addition, North Dakota populations tolerated high total sulfates, total alkalinity, and total chlorides. *P. gyrina* populations show low variability in their calcium:tissue ratios over a range of environmental calcium values of 31-152 ppm and conductivities of 142-1350 μmhos/cm (Hunter & Lull 1977). This might account for the snails' ability to inhabit waters with a broad spectrum of hardness, pH, and calcium concentration.

Family Planorbidae

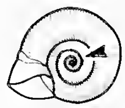
Animal sinistral but shell leaning to left, appearing dextral (ultradextral); upper side (right) umbilical; lower side (left) apical. Shell orbicular, wheel-shaped, disc-shaped, or, rarely, conical, thin to thick, 2-30 mm in diameter; aperture rounded, ovate, or half-moon shaped; genital and respiratory pores opening on left side; pseudobranch present; tentacles long, filiform; one superior and two lateral jaws present; hemoglobin present (Baker 1928a).

Key to the Planorbidae

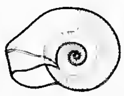
1a. Shell diameter > 10 mm, or if < 10 mm (immatures), then height:diameter ratio > 0.5 2

1b. Shell diameter < 10 mm and height:diameter ratio < 0.5 4

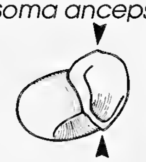
2a. Whorls on apical side increasing only gradually in width so that center has appearance of a coiled rope (an Archimedes spiral); aperture flaring outward in mature specimens .... *Helisoma campanulatum*



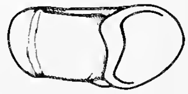
2b. Whorls on apical side increasing rapidly in width (a geometric spiral) 3



3a. Whorls sharply angled on both sides .... *Helisoma anceps*



3b. Whorls on one side rounded to only slightly angled .... *Helisoma trivolvis*



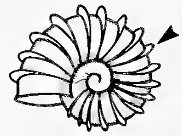
4a. Shell very flat and sharply angled at outer margin .... *Promenetus exacuous*

4b. Shell not as above 5

5a. Teeth or lamellae present inside shell to a third of whorl behind aperture .... *Planorbula armigera*

5b. Teeth teeth and lamellae absent 6

6a. Shell with distinct raised ridges .... *Gyraulus crista*

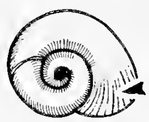


6b. Shell without ridges 7

7a. Shell flattened on one side and rounded on the other, shoulder flattened .... *Micromenetus dilatatus*

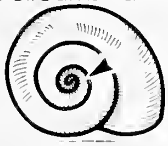
7b. Shell rounded on both sides, not shouldered 8

8a. Shell with at least earliest whorls hirsute (appearing "hairy" when shell is dry) .... *Gyraulus deflectus*



8b. Shell not hirsute 9

9a. Both top and bottom of shell nearly identical; whorls increasing only gradually in width .... *Gyraulus circumstriatus*



9b. Top and bottom of shell clearly different; whorls increasing rapidly in width .... *Gyraulus parvus*

Gyraulus deflectus (Say, 1824)

Flexed gyro
Figs. 22a, 25

Shell depressed, planorboid, 8 mm in diameter, light tan to brown; spiral lines consisting of periostracal hair-like projections present; umbilicus wide, deep, showing all whorls; spire flat, all whorls in same plane except sunken apical whorl; whorls 4.5; base slightly concave, flattened, showing all volutions, sometimes acutely keeled peripherally; sutures impressed; aperture suboval, more or less deflected, higher than wide; interior brown; outer lip acute, thin; superior portion produced much beyond inferior portion; inside slightly thickened; callus thin, white (Baker 1928a, Clarke 1981).

Gyraulus deflectus occurs from mainland Canada north to the central Arctic coast and throughout Alaska, south to Nebraska, and east to Virginia (Baker 1928a; Clarke 1973, 1981; Jokinen 1983; Branson *et al.* 1987, Burch 1989).

Sites in New York where this species was found during this survey are: Delaware River watershed (455, 456); Hudson River watershed (212, 290, 291, 292, 300, 301, 304, 305, 384, 604); Mississippi-Ohio River watershed (427B); St. Lawrence River watershed (141A, 141D, 259A, 260, 262, 263, 264, 306, 313, 332, 336, 338, 339, 340, 349, 350, 352, 390, 401, 448A, 493, 497, 500, 502A); and Atlantic coastal drainage (253). Harman & Berg (1971) collected populations (determined as *G. hirsutus*) from lakes at the headwaters of the Tioughnioga River in the Susquehanna River watershed.

Gyraulus deflectus has been collected at numerous sites in New York State. Early reports include: Mohawk River; Newcomb's Pond, Pittstown, Rensselaer County (De Kay 1843); lakes in Herkimer and Otsego Counties (Lewis 1856b, 1860, 1872); Staten Island, Richmond County (Hubbard & Smith 1865); Onondaga County (Beauchamp 1886b); Brighton, Monroe County (Walton 1891); Albany/Troy region, Albany and Rensselaer Counties (Marshall 1895); Greenbush, Rensselaer County; Erie Canal, Monroe County; Little Lakes, Herkimer County; Seneca River (Marshall 1894); Chautauqua Lake, Chautauqua County (Maury 1898, 1916; Townes 1937); Irondequoit Bay, Lake Ontario, Monroe County (Baker 1900b); Cazenovia Lake, Madison County (Henderson 1907); Cayuga Lake, Seneca and Cayuga Counties (Maury 1916, Harman & Berg 1971); Fall Creek, Ithaca, Tompkins County; Cayuta Lake, Schuyler County; Hemlock Lake, Livingston and Ontario Counties (Maury 1916); and Oneida Lake, Oswego and Onondaga Counties (Baker 1916a, b; 1918a, b; Pratt 1923). More recent reports include Upper Cassadaga Lake, Chautauqua County (Townes 1937); Sodus Creek, Wayne County; Salmon River, Monroe County (Burdick 1939); Schroon River, Adirondack State Park, Warren County (Jacobson 1945); and Cross Lake, Cayuga and Onondaga Counties (Harman & Berg 1971).

This species lives in all types of permanent, quiet waters, including woods pools and dark streams issuing from swamps (Baker 1928a, Goodrich 1932, Dawley 1947, Jokinen 1983, Strayer 1987). It also lives in the tidal Hudson River (Strayer 1987). During this survey, populations were found living in ten river and stream sites, 16 lakes, five permanent ponds, two temporary ponds, three marshes, and two canals. Substrata can be of various types, including allochthonous organic matter with filamentous green algae (e.g., *Oedogonium* sp. and *Spirogyra* sp.) and rooted aquatic vegetation (Baker 1918a, Clarke 1981, Jokinen 1983). In Oneida Lake, individuals can be found to a depth of 9 m (Baker 1918a).

In a small, eutrophic lake in Connecticut, these snails have a bivoltine life cycle. Eggs first appear after the water temperature raises above 23°C from late June to early July. The hatchlings from this brood mature and produce a second batch of eggs from early September through early October. The autumn-hatched young overwinter and produce eggs the following spring (Jokinen 1985).

For 36 of this survey's New York sites, the water chemistry values are: pH: 6.4-8.5 (7.2 ± 0.1), conductivity: 47-2320 µmhos/cm (287 ± 63), Ca^{++}: 1-89 ppm (21 ± 3), and Na^{+}: 1-291 ppm (19 ± 8). In Connecticut, 29 sites had chemistry values of pH: 5.6-7.0, conductivity: 43-319 µmhos/cm, Ca^{++}: 1-4 ppm, and Na^{+}: 2-29 ppm (Jokinen 1983). Three sites in central New York had pH values of 7.1-8.3 (7.8) (Harman & Berg 1971). *G. deflectus* can live in waters with a broad range of calcium concentrations, pH, and salinity. In the Adirondack Mountains, it occurs at all altitudes and water chemistry values (Jokinen 1991).

Gyraulus parvus (Say, 1817)

Ash gyro
Figs. 22b, 25

Shell depressed, 5 mm in diameter, tan to black; umbilicus wide, shallow, exhibiting all volutions; spire flat, with

first two whorls sunken below body whorl; nucleus small, rounded; whorls 3.5, rapidly enlarging, rounded below periphery, flattened above; body whorl somewhat flattened above; sutures deeply impressed; aperture elongate-oval, usually nearly in same plane as body whorl; interior white to pale yellow; outer lip acute, thin; superior margin produced more than inferior margin; callus a thin wash on parietal wall (Baker 1928a).

The distribution of this species is broad, including all of Canada south of the tree line, and south to California, Florida, and Cuba (Taylor 1960, 1981; Clarke 1981).

G. parvus occupies all the major watersheds of New York: Delaware River watershed (455, 457, 470, 471, 472, 475); Hudson River watershed (212, 265, 268, 269, 270, 271, 275, 276, 277, 282, 283, 285, 286, 288, 289, 291, 292, 293, 300, 301, 303, 317, 319, 320, 367, 387, 459, 460, 461, 588, 600, 601, 602, 604, 608, 610, 616); Mississippi-Ohio River watershed (426, 430A, 430B, 431); St. Lawrence River watershed (141B, 141D, 259A, 259B, 261, 262, 263, 278, 279, 280, 298, 306, 307, 308, 309, 311, 313, 314, 332, 336, 337, 338, 339, 340, 341, 343, 349, 351, 360, 361, 371, 373, 375, 390, 392, 407, 408, 409, 410, 412, 439, 440, 441, 445A, 445C, 448A, 448B, 449, 450, 493, 495, 496, 498, 499, 500, 501, 502A, 502B, 505, 512, 515, 520, 523, 524A, 524B, 527, 529, 531, 534, 535, 562, 563); Susquehanna River watershed (400, 539, 540, 542, 543, 546, 558, 568, 569, 570, 571, 572, 573, 577, 579, 580, 582, 583, 586, 592, 593, 594); Atlantic coastal drainage (253, 322); Hackensack River watershed (606); and the Housatonic River watershed (294). Harman & Berg (1971) found a large number of localities from the Susquehanna and Otsego River basins in central New York. Strayer (1987) reported that *G. parvus* is abundant everywhere in the Hudson River basin.

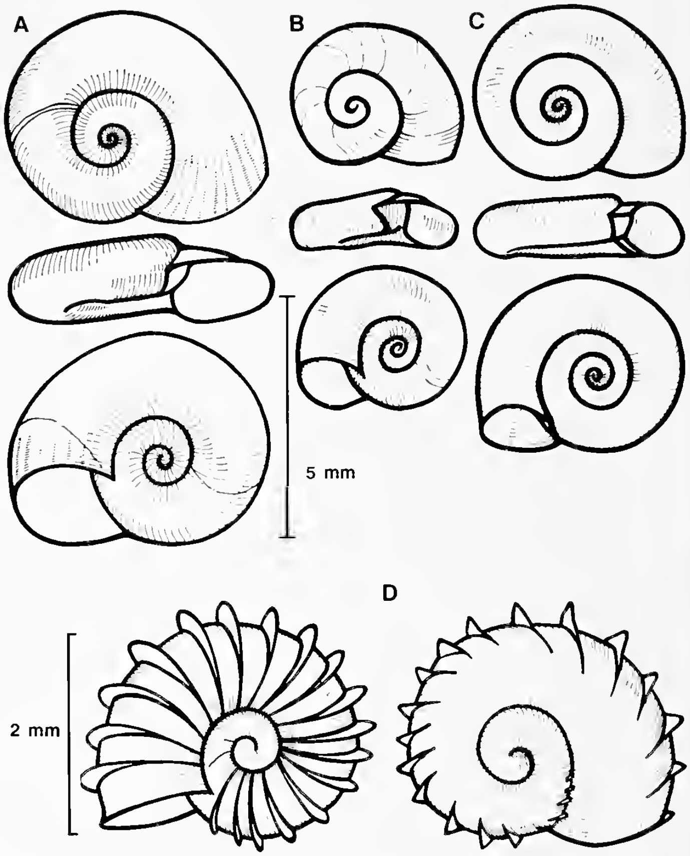


Fig. 22. Family Planorbidae, shells: a, *Gyraulus deflectus;* b, *G. parvus*, c, *G. circumstriatus;* d, *G. crista.* Figs. a-c are drawn to the same scale.

In the past, *G. parvus* also was reported from many sites in New York State. Early citations include the Mohawk River (De Kay 1843); Herkimer and Otsego Counties (Lewis 1856b, 1860, 1872); Staten Island, Richmond County (Hubbard & Smith 1865); Tibbet's Brook, Riverdale, Bronx County (Prime 1880); Onondaga County (Beauchamp 1886b); Charlotte, Monroe County (Walton 1891); Albany/Troy region, Albany and Rensselaer Counties (Marshall 1895); Mohawk River, Cohoes, Albany County; Normans Kill, Albany, Albany County (Marshall 1894); Chautauqua Lake, Chautauqua County (Maury 1898, 1916; Townes 1937); Owasco River near Auburn, Cayuga County (Baker 1899); Irondequoit Bay, Lake Ontario, Monroe County (Baker 1900b); Cazenovia Lake, Madison County (Henderson 1907); Long Island (Wheat 1907a); Fort Erie trenches, Frenchmen's Creek; Lime Lake, Cattaraugus County (Letson 1909); Cayuga Lake, Seneca and Cayuga Counties (Maury 1916); Oneida Lake, Oswego County (Baker 1916a, b; 1918a, b; Pratt 1923). More recently, collections have been made at the Hudson River, Dutchess County (Townes 1936); Findley Lake, Bear Lake, Upper Cassadaga Lake, Lower Cassadaga Lake, and Clymer Pond, Chautauqua County (Townes 1937); Lake Ontario bays (Burdick 1939); Adirondack State Park, Warren County (Jacobson 1945); Lake Beechwood and Lake Mohegan, Peekskill, Westchester County; Hempstead State Park, Nassau County, Long Island; "Kensington Pond;" Valley Stream, Nassau County, Long Island (Jacobson & Emerson 1961); Green Lake, Onondaga County (Harman 1970); and Otsego Lake, New Pond, and Canandarago Lake, Otsego County (Harman 1971, 1973; MacNamara & Harman 1975).

G. parvus habitats include permanent and temporary ponds, small lakes, quiet embayments of large lakes, pools of permanent and intermittent streams, and marshes (Lewis 1856b; Goodrich 1932; Burdick 1939; Leonard 1959; Jacobson & Emerson 1961; Harman & Berg 1971; Clarke 1973, 1981; Cvancara 1983; Strayer 1987). These snails also occur in the tidal Hudson River (Strayer 1987). In Connecticut, they were found most commonly in ponds of one to nine hectares surface area (Jokinen 1983). During the current survey, populations were found in 42 river and stream sites, 44 lakes, 38 permanent ponds, two temporary

ponds, three ditches, four marshes, six canals, and a swamp. This species is fairly ubiquitous in quieter waters.

Preferred microhabitats of *G. parvus* include allochthonous organic matter, tree branches, stones, and aquatic plants such as *Potamogeton, Myriophyllum, Vallisneria, Typha, Spirogyra* and *Chara* spp. (Baker 1927, Goodrich 1932, Leonard 1959, Jacobson & Emerson 1961, Eckblad 1973, Clarke 1981, Jokinen 1983). Substrata can be anything from mud to rock (Clarke 1981, Pace *et al.* 1979, Cvancara 1983). In Grand Traverse Bay, Lake Michigan, offshore densities of 2.4-28.4 snails/m^2 have been reported (Pace *et al.* 1979). In a pond habitat, distributions can be aggregated (Eckblad 1973).

Laboratory observations indicate that this species deposits capsules containing 1-7 eggs. They are laid at night on aquarium glass, stems and leaves of dead and living vegetation, and snail shells. Development takes 6-10 days (Krull 1931, Leonard 1959). The snails hatch with shells 0.5 mm in diameter. In 15-17 days they are half-grown, and in 4-5 weeks they are fully grown. At 6-7 weeks they are mature and ready to oviposit (Krull 1931). In field populations, eggs are present from June through September. The species appears to be multivoltine (Eckblad 1973). Food consists of dead terrestrial vegetation, from which the snails consume the leaf pulp, leaving the vascular bundles intact as skeletonized leaves (Krull 1931). They also consume periphyton on submerged aquatic vegetation (Eckblad 1973).

This survey's New York State water chemistry values for 134 *G. parvus* habitats are: pH: 5.8-9.6 (7.2 ± 0.1), conductivity: 42-2320 μmhos/cm (306 ± 25), Ca^{++}: 1-89 ppm (20 ± 1), and Na^{+}: 1-291 (20 ± 3). In Connecticut, chemistry values for 39 sites are: pH: 6.1-10.0, conductivity: 53-346 μmhos/cm, Ca^{++}: 3-42, and Na^{+}: 2-29 (Jokinen 1983). Values for North Dakota are: pH: 7.6-10 (mean = 8.6, 67 sites), conductivity: 300-5000 μmhos/cm (1465, 57 sites), and Ca^{++}: 50-360 ppm (146, 21 sites) (Cvancara 1983). For 79 central New York sites, Harman & Berg (1971) recorded pH values of 6.8-8.5 (7.6). In the Adirondack Mountains, this species is ubiquitous, occurring at all altitudes and in all water chemistry types (Jokinen 1991). Its tolerance to wide ranges of pH and calcium concentrations is reflected in its wide geographic and habitat distributions. Even though *G. parvus* lives in the tidal Hudson River (Strayer 1987), the data do not demonstrate a high sodium tolerance.

Gyraulus circumstriatus (Tryon, 1866)

Disc gyro
Figs. 22c, 25

Shell depressed, planospiral, 5 mm in diameter, semitransparent; umbilicus wide, all whorls visible; spire whorls rounded, usually in same plane; whorls 4.5, slowly and regularly increasing in diameter; last whorl not greatly enlarged over previous, with several raised revolving lines on base; body whorl slightly rounded, slightly flattened above, obtusely subangulate below; sutures deeply impressed; aperture roundly ovate, not oblique; outer and inner lips often joined by parietal callus (Baker 1928a).

This species occurs from Prince Edward Island and New England west to northern British Columbia and south to California, New Mexico, and Kansas (Leonard 1959, Clarke 1981, Taylor 1981, Cvancara 1983, Jokinen 1983).

Populations were collected from eight sites in four watersheds during this survey: Hudson River watershed (290); St. Lawrence River watershed (306, 339, 402); Susquehanna River watershed (536, 537, 555); and the Atlantic coastal drainage (252). Strayer (1987) noted populations from the Hudson River basin. Harman & Berg (1971) did not list this species, and there is no mention of it in the older literature.

G. circumstriatus commonly lives in quiet waters of lakes and ponds and in intermittent ponds and streams. During this survey, populations were found in one river, two lakes, three permanent ponds, one temporary pond, and one ditch. Substrata range from mud to gravelly sand, and the snails are often associated with dead and living aquatic vegetation (e.g., *Chara* sp.) and allochthonous detritus (Leonard 1959, Clarke 1981, Cvancara 1983, Jokinen 1983). A population in Roseland Lake, Connecticut, exhibits continual recruitment of young from May through November. This probably reflects a bivoltine or multivoltine life cycle (Jokinen 1985).

Water chemistry values for seven sites studied during this survey are: pH: 6-9.8 (7.3 ± 0.5), conductivity: 110-312 μmhos/cm (247 ± 25), Ca^{++}: 4-34 ppm (16 ± 5), and Na^{+}: 6-47 ppm (16 ± 5). Connecticut values for three sites are: pH: 6.2-7.3, conductivity: 61-316 μmhos/cm, Ca^{++}: 3-20 ppm, and Na^{+}: 5-8 ppm (Jokinen 1983). Seven sites in North Dakota had values of: pH: 7.6-10.0 (8.7), conductivity: 293-4650 μmhos/cm (1500), and Ca^{++}: 110 ppm (single reading) (Cvancara 1983). Populations were not found in the acidic waters or high altitudes of the Adirondack Mountains (Jokinen 1991). The data available indicate that this species might be intolerant of waters with extremely low pH and calcium values.

Gyraulus crista (Linnaeus, 1758)

Star gyro
Figs. 22d, 25

Shell depressed, 2 mm in diameter, fragile, tan to brown, variably costate on periphery with folds of periostracum projecting conspicuously; umbilicus region broad, deep, exhibiting all whorls; spire flat; nucleus large, roundly ovate; 2.5 whorls, rapidly increasing in diameter, base well-rounded; sutures deeply impressed to channeled; aperture ovate, flattened above, rounded below, appressed to body wall a short distance, slightly expanded at parietal wall; outer lip thin, simple, touching or appressed to previous whorl (Baker 1928a).

At times, this species has been placed in the genus *Armiger.*

G. crista has a Holarctic distribution. In North America, it ranges from Ontario to the Northwest Territories and Alaska and south to California (Clarke 1973, 1981; Taylor 1981).

Three populations were found during this survey, all in the St. Lawrence River watershed (496, 523, 524A). Neither Strayer (1987) nor Harman & Berg (1971) found sites that harbored this species. The only historical note (Burdick 1939) appears to be on a population in Sodus Bay, Lake Ontario, Wayne County.

G. crista inhabits the slowly flowing water of lake shores, permanent and temporary ponds, and slow-moving streams. During this survey, it was found in one lake and two permanent ponds. The substrata can be mud or muddy sand, and the microhabitat consists of dense aquatic vegetation or water-logged wood and rotting terrestrial leaves (Goodrich 1932, Clarke 1981, Cvancara 1983). Snails remain in shallow water and will often burrow 10 cm into the substratum among the roots of aquatic vegetation (e.g., *Cladium* sp.) (Richardot-Coulet & Alfaro-Tijera 1985).

This species is trivoltine. Egg capsules with one to two eggs are first deposited when the water temperature exceeds 8°C in spring. After ovipositing, the adults die. The early spring hatchlings become reproductively mature by early summer, and they produce a second generation which hatches, matures, and oviposits in autumn. The summer and autumn generations overwinter. Longevities are four months for the spring generation, 10-12 months for the summer generation, and 6-8 months for the autumn generation. There appears to be no differential mortality as all age classes are affected equally throughout the year (Richardot-Coulet & Alfara-Tejera 1985).

Water chemistry values for the three New York State sites studied during this survey are: pH: 7.3, 7.4, 8.2; conductivity: 349, 680, 760 µmhos/cm; Ca^{++}: 29, 34, 36 ppm; and Na^{+}: 58, 83, 122 ppm. In North Dakota, values for three sites are: pH: 7.6-8.5 (8.1) and conductivity: 435-4650 µmhos/cm (1940) (Cvancara 1983). Values from both regions reflect high calcium, neutral environments.

Helisoma anceps (Menke, 1830)

Two-ridge rams-horn
Figs. 23a, 25

Shell ultradextral, discoidal, 19 mm in diameter, yellowish to dark tan, dark brown, or reddish; more or less angulate above and below, with periphery rounded or flattened; umbilicus deep, exhibiting all volutions; spire a funnel-like depression, exhibiting all volutions; nuclear whorl small; whorls 3.5; sutures impressed; aperture lunately-ovate, bluntly rounded or V-shaped above, usually V-shaped below body whorl, higher than wide in mature specimens; outer lip acute, thin, expanded, thickened within by bluish-white varix lined with reddish-brown; callus thin (Baker 1928a).

Synonyms include *Planorbis bicarinatum* Say 1817 and *Helisoma antrosum* Conrad 1834.

This species occurs throughout most of Canada south of the tree line, south to Florida and northwest Mexico. It has been introduced into Italy (Clarke 1981, Cvancara 1983, Thompson 1984a).

H. anceps is widespread across New York in all the major watersheds: Delaware River watershed (466, 471, 473, 474, 475); Hudson River watershed (141D, 212, 271, 274, 275, 277, 285, 292, 293, 295, 302, 303, 304, 305, 320, 321, 381, 383, 384, 385, 386, 452, 459, 599, 600, 604, 607, 616); Mississippi-Ohio River watershed (415, 420, 421, 430B); St. Lawrence River watershed (141D, 260, 261, 263, 309, 316, 331, 336, 338, 340, 347, 351, 354, 356, 357, 360, 361, 363, 374, 377, 392, 394, 411, 493, 494, 517, 518B, 530, 531, 534, 535, 562, 563); Susquehanna River watershed (478, 539, 546, 553, 555, 568, 581, 583, 584, 591, 592); and Housatonic River watershed (294). Harman & Berg (1971) found it to be common throughout central New York State. It also is abundant in the lower Hudson River watershed (Strayer 1987).

Historical literature citing localities for *H. anceps* is abundant. Populations have been reported from the State in general (De Kay 1843); Herkimer and Otsego Counties (Lewis 1856b, 1860; Marshall 1894); Riverdale, Bronx County (Prime 1880); Onondaga County (Beauchamp 1886b); Rochester, Monroe County (Walton 1891); Albany/Troy region, Albany and Rensselaer Counties (Marshall 1894, 1895); Chautauqua Lake, Chautauqua County (Maury 1898, Evermann & Goldsborough 1902, Maury 1916; Townes 1937); Highland Lake, Orange County (Mearns 1898); Owasco Lake, Cayuga County (Baker 1899); Canandaigua Lake, Ontario and Yates County (Mitchell 1899; Maury 1916); Irondequoit Bay, Lake Ontario, Monroe County (Baker 1900b); Cazenovia Lake, Madison County (Henderson 1907); Long Island (Wheat 1907a); Erie and Niagara Counties (Letson 1909); Cayuga Lake, Cayuga and Seneca Counties; Cayuta Lake, Schuyler County; Fall Creek, Ithaca, Tompkins County (Maury 1916); Allegany State Park, Cattaraugus County (Pinney & Coker 1934); Oneida Lake, Otsego and Onondaga Counties (Baker 1916a, b; 1918a, b; Pratt 1923); Hudson River from North Germantown, Columbia County, to Rhinecliff, Dutchess County (Townes 1936); Findley Lake, Bear Lake, Upper Cassadaga Lake, and Clymer Pond, Chautauqua County (Townes 1937); Lake Ontario watershed (Burdick 1939); and Schroon River, Adirondack State Park, Warren County (Jacobson 1945). More recent reports include Upper Ferdun Pond, Rockland County (Bretet & Carswell 1952); Oakland Lake, Queens County, Long Island (Jacobson 1965); Green Lake, Onondaga County (Harman 1970); Otsego Lake, Otsego County (Harman 1971, MacNamara & Harman 1975); Wilber Reservoir, Moe Pond, and Susquehanna River, Oneonta, Otsego County; and Delaware River, Walton, Delaware County (Katsigianis & Harman 1973; MacNamara & Harman 1975).

Helisoma anceps exists in a wide range of habitats, including lakes, ponds, rivers, streams, and occasionally temporary ponds or intermittent streams. During this survey, it was found in 17 river and stream sites, 33 lakes, 25 permanent ponds, three temporary ponds, one ditch, two marshes, and three canals. Its substrata include allochthonous organic matter, rocks, living and dead aquatic vegetation, sand, and mud (Baker 1928a, Goodrich 1932, Franzen & Leonard 1942, Dawley 1947, Clarke 1981, Taylor 1981, Jokinen 1983, Cvancara 1983, Strayer 1987, Pip 1987). The abundance of this species indicates that it has good dispersal and colonization rates (Jokinen 1987). Food consists of diatoms and other algae (Goodrich 1932).

Apparently the longevity of this species is variable. In Connecticut, the snails live one year. They reach maturity in early spring, oviposit, then die. Hatchlings appear from mid May, when the water temperature exceeds 20°C, through July (Jokinen 1983). Under other circumstances, *H. anceps* appears to live two years, not reproducing until its second summer when the shell diameter exceeds 8 mm (Boerger 1975, Hermann & Harman 1975). Egg deposition occurs when the water temperature exceeds 10°C. The egg laying period is long, up to 18 weeks, and during the first eight weeks, the snails deposit an average of 300 eggs each. They continue to grow during oviposition and produce more eggs/snail as their shell diameters increase (Boerger 1975).

Water chemistry values for the 83 survey sites in New York State are: pH: 5.8-9.5 (7.1 ± 0.1), conductivity: 28-2320 μmhos/cm (238 ± 31), Ca^{++}: 1-89 ppm (14 ± 2), and Na^{+}: 1-291 ppm (18 ± 4). In Connecticut, the data for 54 sites are: pH: 5.8-8.9, conductivity: 40-387 μmhos/cm, Ca^{++}: 2-35 ppm, and Na^{+}: 2-29 ppm (Jokinen 1983). In central New York, Harman & Berg (1971) found *H. anceps* in a pH range of 7.1-8.4 (7.7). Values from North Dakota are: pH: 8.1-9.2 (8.7, 15 sites), conductivity: 461-1870 μmhos/cm (765, 8 sites), and Ca^{++}: 50-170 ppm (111, 7 sites) (Cvancara 1983). In Canada, the species has a relatively high tolerance to a wide range of chemical parameters (Pip 1987). In the Adirondack Mountains and surrounding lowlands, it is ubiquitous, occurring at all altitudes and in waters with a wide range of chemical parameters (Jokinen 1991). *H. anceps* appears to have few chemical restrictions, a likely factor in its widespread continental and local distribution.

Helisoma campanulatum (Say, 1821)

Bellmouth rams-horn
Figs. 23b, 25

Shell discoidal, rounded below, subcarinate above, base exhibiting 2.5 volutions, 16 mm in diameter, brown to reddish; umbilicus deep; spire flat, exhibiting all volutions, closely coiled; nuclear whorl small; whorls 4.5; last half of body whorl often elevated above general plane of spire; sutures deeply impressed; aperture lunate, dilated in mature specimens, forming bell-shaped lip, slightly wider than high; outer lip thin, sharp, heavily ridged within where aperture begins to expand; parietal callus thin (Baker 1928a).

Burch (1989) places this species in the genus *Planorbella.*

H. campanulatum occurs from Vermont west to Saskatchewan and south to Minnesota, Ohio, and Illinois. Only a fossil has been found in North Dakota (Baker 1928a, Clarke 1973, Cvancara 1983).

During this survey of New York State, this species was located at 41 sites and in all major watersheds: Delaware River watershed (457, 466); Hudson River watershed (212, 276, 283, 293, 297, 300, 317, 318, 320, 384, 604, 616); Mississippi-Ohio River watershed (430B); St. Lawrence River watershed (141D, 259A, 260, 263, 278, 298, 306, 307, 309, 336, 337, 338, 339, 340, 341, 344, 350, 352, 353, 493, 531, 562); Susquehanna River watershed (568, 582, 592); and Housatonic River watershed (294). Strayer (1987) found it in the lower Hudson River basin, and postglacial fossil evidence indicates that this species might have been more abundant previously. In central New York, Harman & Berg (1971) noted colonies in both the Susquehanna and Otsego River basins.

Helisoma campanulatum was first noticed in "most of the lakes in the western end of the state" (De Kay 1843). Following that record, colonies were noted from Herkimer and Otsego Counties (Lewis 1856b, 1860); Onondaga County (Beauchamp 1886b); Pittsford, Monroe County (Walton 1891, Marshall 1894); Cedar Lake, Herkimer County (Marshall 1894); Chautauqua Lake, Chautauqua County (Maury 1898, Evermann & Goldsborough 1902, Maury 1916, Townes 1937); Canandaigua Lake, Ontario and Yates Counties (Mitchell 1899); Owasco River near Auburn and the inlet of Lake Owasco at Cascade, Cayuga County (Baker 1899); Irondequoit Bay, Lake Ontario, Monroe County (Baker 1900b); Cazenovia Lake, Madison County (Henderson 1907); Lime Lake, Cattaraugus County, and the Niagara River (Letson 1909); Oneida Lake, Oswego County (Baker 1916a, b; 1918a, b; Pratt 1923); Cayuta Lake, Schuyler County; and Conesus Lake, Livingston County (Maury 1916). More recent records include Findley Lake, Bear Lake, Upper Cassadaga Lake, and Lower Cassadaga Lake, Chautauqua County (Townes 1937); Little Sodus Bay, Lake Ontario, Cayuga County; Glenwood Lake, Orleans County (Burdick 1939); Brant Lake, Adirondack State Park, Warren County (Jacobson 1945); Otsego Lake, Otsego County (Harman 1971, MacNamara & Harman 1975); and Conesus Lake, Livingston County (Wade & Vasey 1976).

This species is found primarily in ponds and lakes. During this survey, it was found in five river and stream sites, 19 lakes, 12 permanent ponds, one temporary pond, two

marshes, and two canals. It is associated with a variety of substrata, such as rock, sand, mud, allochthonous detritus, and occasionally rooted aquatic vegetation (Baker 1918a, 1928a; Jokinen 1983, Pip 1987). In Oneida Lake, Baker (1918a) found the species on all types of substrata, 0.5-3.0 m deep, associated with the filamentous algae *Oedogonium, Spirogyra*, and *Cladophora* spp. Harman & Berg (1971) located individuals in Oneida Lake, where they were most common at 5-9 m.

This species has an annual life cycle. It has a distinct reproductive peak in the spring, from the end of May through July, after which the adult snails die. The hatchlings grow rapidly and obtain a shell diameter of over 10 mm by summer's end. The snails overwinter as adults (Boerger 1975; Jokinen 1985). *H. campanulatum* is present in most species-rich habitats, and it is less frequent in species-poor habitats. It is generally absent from ponds with fewer than three species (Jokinen 1987).

Water chemistry values for the 41 New York sites of the present survey are: pH: 6.1-9.2 (7.3 ± 0.1), conductivity: 42-2320 µmhos/cm (272 ± 55), Ca^{++}: 1-89 ppm (18 ± 3), and Na^{+}: 1-291 ppm (18 ± 7). In Connecticut, water chemistry values for 16 sites are: pH: 5.8-7.6, conductivity: 38-319 µmhos/cm, Ca^{++}: 1-27 ppm, and Na^{+}: 2-8 ppm (Jokinen 1983). Harman & Berg (1971) found the species at 16 sites with a pH range of 7.1-8.3 (7.8). In the acidic Adirondack Mountain waters and surrounding hard-water areas, this species is ubiquitous. Distribution does not seem to be limited by low water chemistry values or high altitude (Jokinen 1991). However, the species seems to succeed best in lakes and larger ponds, as described by Pip (1987) for Canadian populations.

Helisoma trivolvis (Say, 1817)

Marsh rams-horn
Figs. 23c, 25

Shell discoidal, flat, carinate above, subcarinate below, 32 mm in diameter, yellowish to brownish to chestnut; umbilicus narrow, deep, funnel-shaped; spire perfectly flat in young, sunken below last whorl in adults, exhibiting all volutions; nuclear whorl small; whorls 4.0, rounded on periphery; base indented, showing 2-3 volutions; sutures deep, V-shaped; aperture broadly lunate, somewhat expanded below, with V-shaped angle above, exactly the height of body whorl, bluish-white or tan, bordered within by wide brown or yellow band; outer lip thin, acute, rounded outward; callus thin (Baker 1928a).

Burch (1989) places this species in the genus *Planorbella*.

This species occurs throughout the Canadian boreal forest and New England, south to the Mississippi River drainage, Florida, and the Dominican Republic (Baker 1928a, Branson 1963, Beetle 1973, Clarke 1973, Thompson 1984a, Gomez *et al.* 1986).

Helisoma trivolvis is abundant and found in all of New York's major watersheds: Delaware River watershed (455, 458, 474); Hudson River watershed (96B, 96D, 96F, 96G, 269, 271, 274, 282, 286, 288, 289, 290, 291, 317, 367, 453, 608, 609); Mississippi-Ohio River watershed (415, 420, 426, 427A, 428, 430B, 431); St. Lawrence River watershed (141A, 259B, 260, 261, 263, 307, 308, 309, 312, 314, 316, 331, 332, 337, 338,

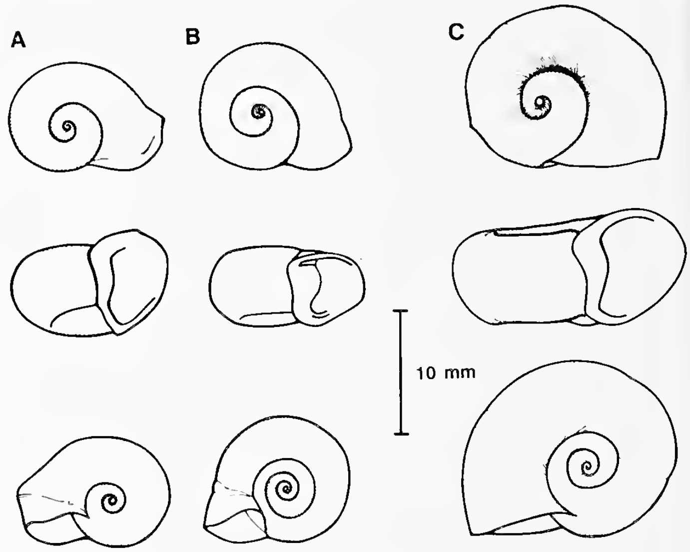


Fig. 23. Family Planorbidae, shells: a, *Helisoma anceps*; b, H. *campanulatum;* c, *H. trivolvis*. All illustrations are drawn to the same scale.

339, 343, 376, 390, 392, 396, 405, 408, 409, 439, 440, 441, 443, 444, 445B, 448A, 448B, 449, 450, 493, 494, 497, 500, 502A, 502B, 503, 507, 512, 518B, 524A, 524B, 527, 533, 534, 562, 563); and Susquehanna River watershed (537, 546, 552, 553, 569, 571, 572, 573, 591, 592, 594). Harman & Berg (1971) and Strayer (1987) found it to be abundant in central New York and the Hudson River basin, respectively.

There are also numerous earlier reports of *H. trivolvis* occurring in New York State. Sites include: New York State in general (De Kay 1843); Herkimer and Otsego Counties (Lewis 1856b, 1860, 1872); Riverdale, Bronx County; Van Cortland Lake, Bronx County (Prime 1880); Onondaga County (Beauchamp 1886b); Erie Canal between Ilion and Utica, Herkimer County (Baily 1891); Charlotte, Monroe County (Walton 1891); Albany/Troy area, Albany and Rensselaer Counties (Marshall 1895); Normans Kill, Albany,

Albany County; Cortland, Cortland County; Greenbush, Rensselaer County; Onondaga Lake, Onondaga County (Marshall 1984b); ponds and the Hudson River, Orange and Ulster Counties (Mearns 1898); Canandaigua Lake, Ontario and Yates Counties (Mitchell 1899; Maury 1916); Owasco Lake, Cayuga County (Baker 1899); Genesee River, above and below falls, Irondequoit Bay, Lake Ontario, Monroe County; and Erie Canal "Wide-Waters," Monroe County (Baker 1900b, 1901); Chautauqua Lake, Chautauqua County (Evermann & Goldsborough 1902; Maury 1898, 1916; Townes 1937); Cazenovia Lake, Madison County (Henderson 1907); Long Island (Wheat 1907a, Jacobson 1951); Prospect Park Lake, Brooklyn, Kings County (Wheat 1907b; Freas 1950a); Erie and Niagara Counties (Letson 1909); Conesus Lake, Livingston County (Maury 1916, Wade & Vasey 1976); and Oneida Lake, Oswego County (Baker 1916a, b; 1918a; Pratt 1923). More recent reports are from: lake at school, Allegany State Park, Cattaraugus County (Pinney & Coker 1934); Hudson River from Coxsackie, Greene County to Camelot, Dutchess County (Townes 1936); Clymer Pond, Chautauqua, Chautauqua County (Townes 1937); ponds and creeks of Lake Ontario watershed (Burdick 1939); Brooklyn Botanic Gardens stream, Kings County (Freas 1950a; Jacobson & Emerson 1961); near Valley Stream, Nassau County, Long Island (Jacobson & Emerson 1961); Oakland Lake, Queens County, Long Island (Jacobson 1965); Otsego Lake, Otsego County (MacNamara & Harmann 1975).

Helisoma trivolvis inhabits a wide variety of aquatic habitats, from temporary ponds and streams to rivers and lakes. During this New York State survey, 29 river and stream sites, 18 lakes, 20 permanent ponds, two temporary ponds, three ditches, four marshes, eight canals, and a swamp were found to harbor it. This species lives on various substrata, from clay and mud to boulders, allochthonous organic material, algal species of *Chara* and *Spirogyra*, and rooted aquatic vegetation, such as *Myriophyllum*, *Ceratophyllum*, *Elodea*, *Lemna*, *Potamogeton*, *Typha*, and *Scirpus* spp. (Baker 1918a, 1928a; Leonard 1959; Branson & Batch 1983; Cvancara 1983; Jokinen 1983; Strayer 1987; Pip 1987). The immatures seem to prefer macrophytes, whereas the mature snails are most frequently found on inorganic substrata (Harman 1972).

Helisoma trivolvis has variable longevity and reproductive patterns. In a South Carolina impoundment where annual water temperatures range from 11-36°C, it has two periods of egg deposition, one from May through June and a second from late August to mid February. It appears that longevity is one year or less (Wood 1978). In cooler climates, the life span can be one to two years, dependent upon the temperature and trophic richness of the habitat. In richer and warmer habitats, snails reach maturity and oviposit at one year of age. In less rich and cooler habitats, they do not mature and oviposit until their second year (Eversole 1978, Morris & Boag 1982). Individuals are at least 18 mm in diameter before maturation. Egg capsules contain 24-30 eggs and appear in June in Waterloo, Ontario (Boerger 1975), and as early as March in Kansas, where they continue to appear through November or later (Leonard 1959).

This species is a generalist, consuming similar amounts of periphyton, detritus, and carrion (Brown 1982). The size and thickness of its shell allows it to maintain viable populations in co-existence with predators, such as crayfish (Covich 1981). It has high dispersion rate and colonization success (Jokinen 1987, Pip 1987).

Water chemistry data from 78 sites studied during this survey are: pH: 5.8-8.6 (7.4 ± 0.1), conductivity: 48-2320 µmhos/cm (371 ± 35), Ca^{++}: 1-89 ppm (26 ± 2), and Na^{+}: 1-291 ppm (26 ± 5). For 20 sites in Connecticut, values are: pH: 6.3-10.0, conductivity: 89-316 µmhos/cm, Ca^{++}: 6-23 ppm, and Na^{+}: 5-12 ppm (Jokinen 1983). Sites in North Dakota yielded pH: 7.6-9.8 (mean = 8.5, 34 sites), conductivity: 293-5000 µmhos/cm (1185, 32 sites), and Ca^{++}: 60-130 (99, 7 sites) (Cvancara 1983). Values of pH for 52 sites in central New York were 7.0-8.4 (7.6) (Harman & Berg 1971). In the Adirondack Mountains and surrounding lowlands, *H. trivolvis* appears to be limited to sites with Ca^{++} values greater than 9 ppm (Jokinen 1991). Laboratory studies have demonstrated that adults can survive pH values as low as 4.9 and have normal fecundity. However, low pH values cause high percentages of embryonic abnormalities and juvenile mortality (Hunter 1988). However, Pip (1987) found *H. trivolvis* to have the widest tolerance ranges for water chemistry values as well as water body and substratum types.

Planorbula armigera (Say, 1821)

Thicklip rams-horn
Figs. 24a, 26

Shell depressed, subcarinate above and below periphery, 8 mm in diameter, yellow to brown to black; umbilicus round, deep, wide, funnel-shaped, exhibiting all volutions; spire concave, apical whorls depressed below general plane; whorls 4.5, regularly and slowly increasing in diameter, with base rounded; body whorl abruptly deflected near aperture; aperture subovate, slightly oblique, armed within by 6 lamellae, pearly white with reddish band just within aperture extending parallel to its edge; outer lip acute, slightly thickened inside; superior margin slightly produced (Baker 1928a).

This species occurs from New Brunswick and James Bay south to Georgia and west to Minnesota (and possibly North Dakota) (Baker 1928a, Goodrich 1932, Dawley 1947, Freed 1957, Beetle 1973, Clarke 1981, Cvancara 1983, Jokinen 1983, Branson *et al.* 1987).

Planorbula armigera was found at only three sites during this survey: the Delaware River watershed (462) and the St. Lawrence River watershed (259B, 450). Harman & Berg (1971) located populations in the St. Lawrence-

Oswego River watershed, and Strayer (1987) reported the existence of museum specimens from the Hudson River basin.

Historical records indicate that this species is possibly more abundant across the State than recent collections imply. De Kay (1843) found it to be common in all parts of the State. It was later reported to occur in Herkimer and Otsego Counties (Lewis 1856, 1860, 1872); Riverdale, Bronx County (Prime 1880); Onondaga County (Beauchamp 1886b); Brighton, Monroe County (Walton 1891); Albany/Troy area, Albany and Rensselaer Counties (Marshall 1895); Pittsford, Monroe County (Marshall 1894); Irondequoit Bay, Lake Ontario, Monroe County (Baker 1900b); Jamaica, Queens County, Long Island (Wheat 1907a); Niagara and Erie Counties (Letson 1909); Cayuga Lake, Cayuga and Seneca Counties (Maury 1916); Oneida Lake, Onondaga County (Baker 1918a, b); Side's Pond, Randolph, Allegany State Park, Cattaraugus County (Pinney & Coker 1934); and Upper Ferdun Pond, between Piermont and Sparkhill, Rockland County (Bretet & Carswell 1952).

P. armigera inhabits relatively stagnant bodies of water, such as ditches, swales, subarctic muskeg, edges of lakes, permanent and temporary ponds, marshes, swamps, and slow streams. Its typical substratum consists of decaying allochthonous vegetation, such as logs and leaves (Baker 1928a, Goodrich 1932, Dawley 1947, Clarke 1981, Harman & Berg 1971, Jokinen 1983). The three sites located during this survey are a slow, marshy stream, a ditch, and a canal.

In a lake habitat, this species is bivoltine. The young first appear in late May, after the water warms to 20°C. Individuals become reproductively mature by autumn and produce a second generation in early September (Jokinen 1985). In temporary pond habitats, the species probably reproduces only once each year and aestivates under logs and leaf litter when the pond dries in summer (Jokinen, unpublished data).

Water chemistry data are available for two of the New York sites (259B and 462): pH: 7.2 and 8.4, conductivity: 371 and 156 µmhos/cm, Ca^{++}: 44 and 23 ppm, and Na^{+}: 10 and 1 ppm. Sixteen sites in Connecticut had pH: 5.7-8.9, conductivity: 53-262 µmhos/cm, Ca^{++}: 2-17 ppm, and Na^{+}: 3 ppm (Jokinen 1983). Values of pH for nine sites in central New York are 6.9-8.4 (7.5) (Harman & Berg 1971).

Micromenetus dilatatus (Gould, 1841)

Bugle sprite
Figs. 24b, 26

Shell flat above, convex below, 3 mm in diameter, tan to brown; umbilicus open, deep; spire flattened; whorls 3.0, bluntly squared around periphery; body whorl with sharp margin on level with spire; sutures impressed; aperture large, expanded, trumpet-shaped (Binney 1865).

Burch (1989) places this species in the genus *Menetus*.

This species occurs on the Atlantic coast from Nova Scotia to Florida and west to the Mexican Plateau, Texas, Oklahoma, and central and northern California (Branson 1963, Beetle 1973, Taylor 1981, Davis 1983, Thompson 1983, Jokinen 1983). A subspecies, *M. d. avus* (Pilsbry), extends south through the Florida peninsula to Haiti, Jamaica, and Panama (Thompson 1983, 1984a).

M. dilatatus was found across New York State in all the major watersheds during this survey, but it was more common in the southeastern part of the State: Delaware River watershed (455, 457, 466, 467, 468, 470, 474, 475); Hudson River watershed (283, 289, 290, 292, 304, 317, 384, 385, 386, 387, 459, 599, 602, 608, 612); Mississippi-Ohio River watershed (420, 421, 430A, 431); St. Lawrence River watershed (338, 354, 396); Susquehanna River watershed (478, 540, 568, 571, 573, 577, 579, 581); Atlantic coastal watershed (251); and the Hackensack River watershed (606). Harman & Berg (1971) collected only one specimen. It was found in a creek in Oswego County, Oswego River watershed. This species is widely distributed in the Hudson River drainage basin in Dutchess, Orange, and Ulster Counties (Strayer 1987).

There are only a few historical records of this species in New York State, including that of Lewis (1874). Later records are from Southold, Suffolk County, Long Island (Wheat 1907a); Lime Lake, Cattaraugus County (Letson 1909); pool by Quaker Run, Allegany State Park, Cattaraugus County (Pinney & Coker 1934); and Coan Pond, Oswego County (Burdick 1939).

M. dilatatus inhabits springs, streams, lakes, ponds, and quiet sections of rivers. In New York State, habitats studied during this survey include five rivers and streams, 20 lakes, 13 permanent ponds, one temporary pond, and a canal. Snails can be found on submerged allochthonous litter and wood, aquatic vegetation, rocks, and gravel (Taylor 1981, Davis 1983, Jokinen 1983, Thompson 1984a, Strayer 1987).

It appears that this species is multivoltine. In Connecticut, young first appear in late May, when water temperatures reach 22°C. A second reproductive period occurs in early August. There is an additional oviposition period in mid September, which might be just an extension of the August period (Jokinen 1985). Egg masses contain one to two eggs, which incubate one to two weeks at room temperature and hatch when shells are 0.3 mm in diameter. Snails are reproductively viable when the shell diameter reaches 1.9 mm (Jokinen 1983, unpublished data). This species has high colonization and dispersal rates (Jokinen 1987).

Water chemistry values for 38 sites in New York State are: pH: 5.8-9.5 (7.1 ± 0.1), conductivity: 28-495 µmhos/cm (141 ± 17), Ca^{++}: 1-35 ppm (7 ± 1), and Na^{+}: 1-63 ppm (11 ± 3). In Connecticut, values for 58 sites are: pH: 5.6-7.5, conductivity: 31-319 µmhos/cm, Ca^{++}: 1-22 ppm, and Na^{+}: 1-22 ppm (Jokinen 1983). One site in central New

York had a pH value of 7.1 (Harman & Berg 1971). In the Adirondack Mountains and surrounding lowlands, *M. dilatatus* occurs at all altitudes and in all types of water. It has a wide chemical tolerance range and is able to survive acidic, low calcium waters, conditions that some other species cannot.

Promenetus exacuous (Say, 1821)

Sharp sprite
Figs. 24c, 26

Shell much depressed, with acute periphery, 9 mm in diameter, tan to brown to reddish; umbilicus narrow, deep, exhibiting all volutions; spire flat; all whorls in same plane or apical whorls slightly sunken; nuclear whorl small, rounded; whorls 4.0, rapidly increasing in diameter, sloping in a flatly-rounded curve to acutely keeled periphery; base of body whorl flatly convex; sutures well-impressed; aperture obliquely, obtusely triangular or ovate; outer lip thin, acute, with superior part much produced above inferior part and expanded near periphery; slight varix thickening lip; callus a thin wash (Baker 1928a).

This species occurs from the Arctic boreal zone in Canada south to California, New Mexico, Nevada, Texas, and east to New England (Baker 1928a, Goodrich 1932, Leonard 1959, Branson 1963, Clarke 1973, Taylor 1981, Cvancara 1983, Jokinen 1983, Pratt 1983).

P. exacuous was found in all major New York State watersheds during this survey: Delaware River watershed (470, 472); Hudson River watershed (212, 265, 269, 284, 285, 290, 304, 317, 384, 461, 599, 602, 604, 607, 615); Mississippi-Ohio River watershed (427B); St. Lawrence River watershed (141A, 141D, 259A, 259B, 306, 313, 314, 336, 338, 339, 340, 390, 441, 445A, 494, 495, 497, 500, 502A, 502B, 512, 524A); Susquehanna River watershed (400, 582, 591, 592, 593); and Hackensack River watershed (606). Harman & Berg (1971) located scattered populations in the Oswego River watershed in central New York. This species is common in the Hudson River watershed (Strayer 1987).

There are numerous references to *P. exacuous* populations in New York. Early references report sites from northern and western New York (De Kay 1843); Herkimer County (Lewis 1860); Onondaga County (Beauchamp 1886b); Albany/Troy area, Albany and Rensselaer Counties (Marshall 1895); Cedar Lake, Herkimer County (Marshall 1894); Chautauqua Lake, Chautauqua County (Maury 1898, 1916); Jamaica, Queens County, Long Island (Wheat 1907a); Cazenovia Lake, Madison County (Henderson 1907); Lime Lake, Cattaraugus County; Erie and Niagara Counties (Letson 1909); Oneida Lake, Onondaga County (Baker 1916a, b; 1918a, b); Cayuga Lake, Cayuga and Seneca Counties (Maury 1916); Red Salamander Hill, Allegany State Park, Cattaraugus County (Pinney & Coker 1934); Hudson River from North Germantown, Columbia County, to Hyde Park, Dutchess County (Townes 1936);

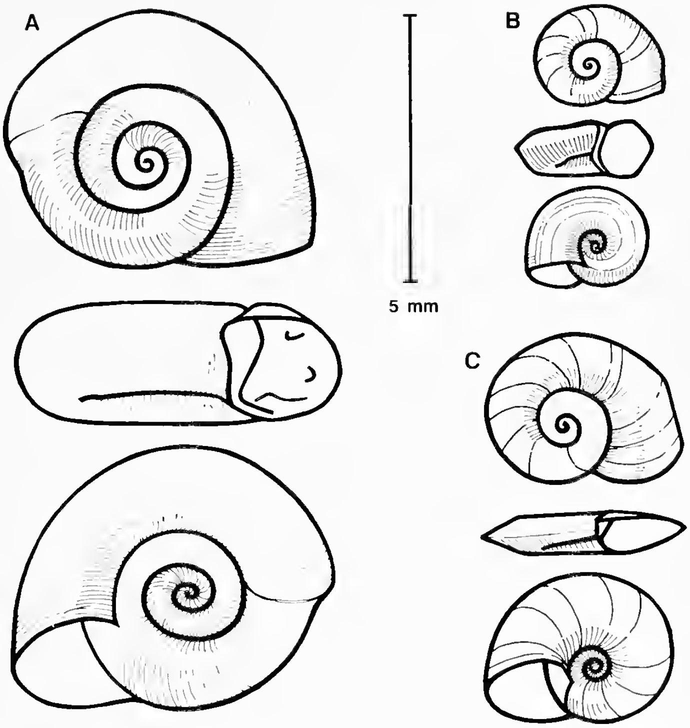


Fig. 24. Family Planorbidae, shells: a, *Planorbula armigera;* B. *Micromenetus dilatatus;* c, *Promenetus exacuous.* All illustrations are drawn to same scale.

Lake Ontario bays; and a backwater of Salmon River, Monroe County (Burdick 1939). More recent reports cite Upper Ferdun Pond, between Piedmont and Sparkhill, Rockland County (Bretet & Carswell 1952); Green Lake, Onondaga County (Harman 1970); Otsego Lake, Otsego County (Harman 1971, MacNamara & Harman 1975); and Conesus Lake, Livingston County (Wade & Vasey 1976).

This species lives in ponds, marshes, slow streams, lakes, sloughs, mountain stream mud flats, temporary ponds, intermittent streams, and swamps. It also inhabits the freshwater tidal Hudson River (Strayer 1987). During this survey, it was found in 14 river and stream sites, 16 lakes, 10 permanent ponds, two temporary ponds, and a marsh. The snails are usually on allochthonous decaying vegetation, like deciduous tree branches and decaying aquatic vegetation, such as floating *Typha* leaves. Other aquatic vegetation on which they can be found includes *Potamogeton*, *Spirodela*, *Riccia*, *Mimulus*, *Eleocharis*, *Scirpus*, and *Zinzania* spp.. Substrata can be mud, decaying organic matter, and shale (Baker 1927, 1928a; Goodrich 1932; Dawley 1947; Leonard 1959; Harman & Berg 1971; Pip & Paulishyn 1971; Harman 1972; Taylor 1981; Cvancara 1983; Jokinen 1983; Pratt 1983).

An isolated population in a temporary pond in Texas demonstrated a semelparous reproductive pattern with an early spring breeding period. January adult densities

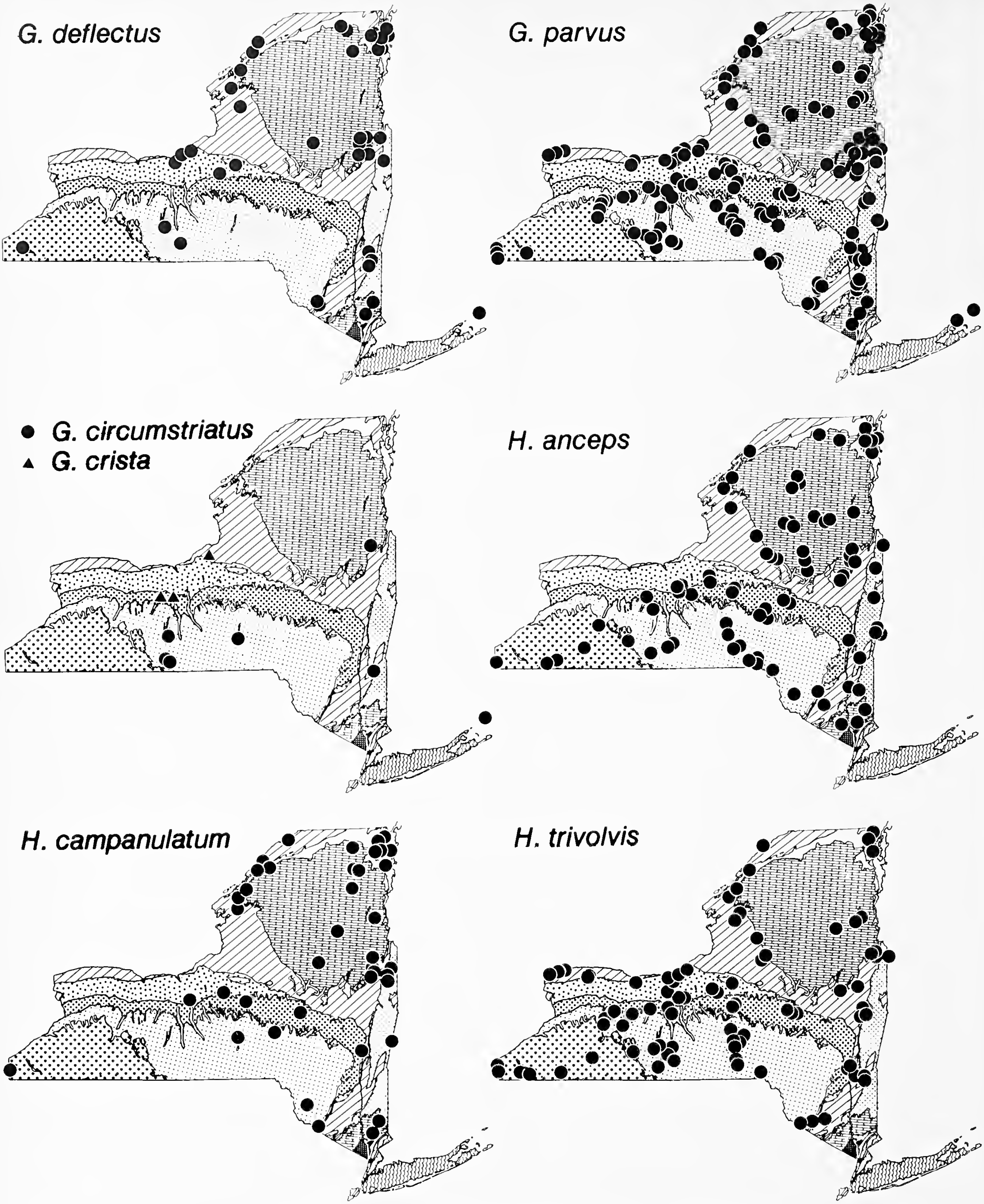


Fig. 25. Known distributions of species of Planorbidae in New York State.

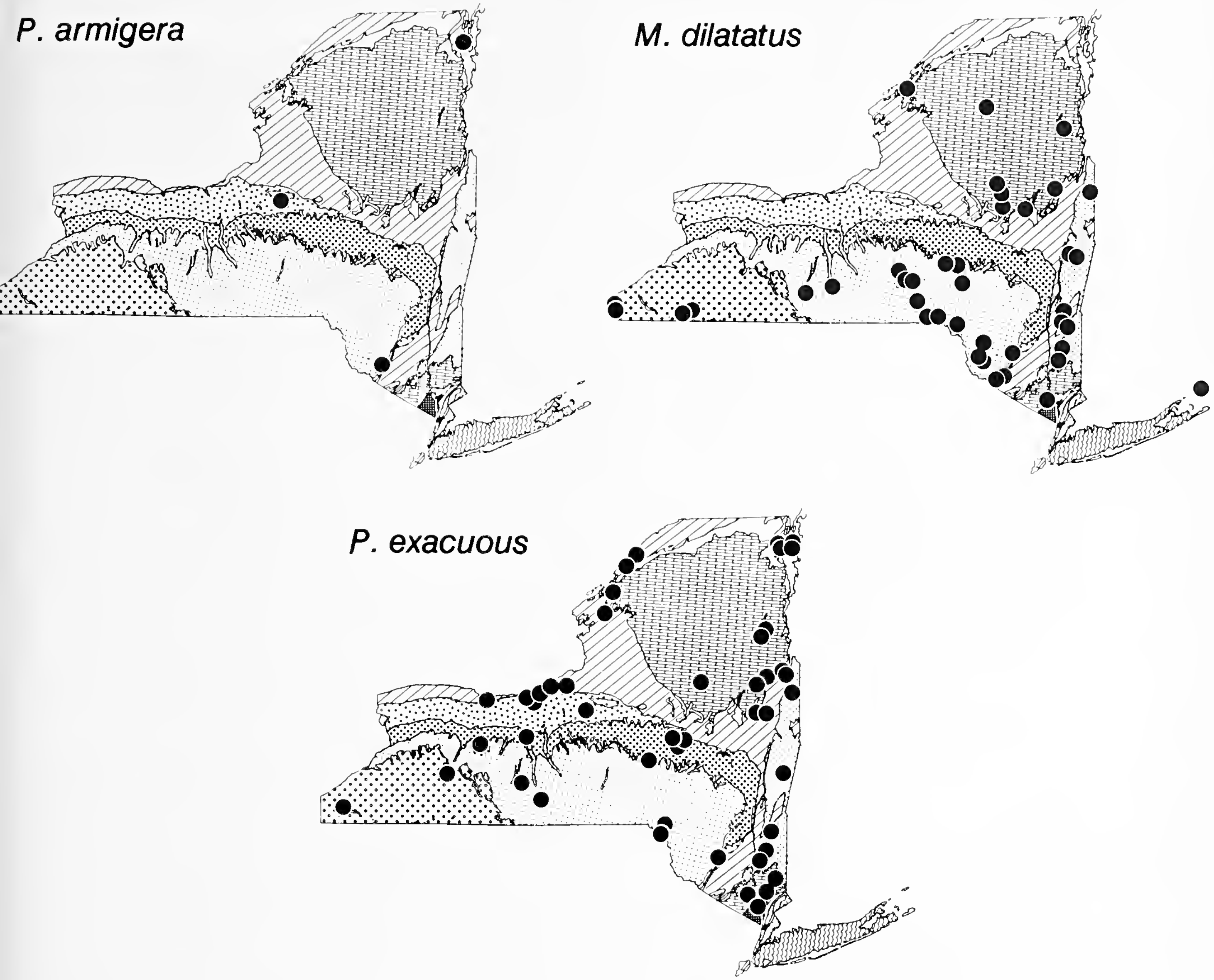


Fig. 26. Known distributions of species of Planorbidae in New York State.

were 13.5 snails/m^2. Postreproductive and juvenile densities in April were 139 snails/m^2 (Pratt 1983). In a Connecticut lake, this species was bivoltine. The first period of reproduction occurred from early July to mid August, when overwintered individuals 6 mm in diameter produced eggs. A second period occurred in early October when hatchlings from the earlier reproductive period reached shell diameters of 4 mm (Jokinen 1985).

Forty-three New York sites located during this survey had the following water chemistry values: pH: 6.3-9.6 (7.3 ± 0.1), conductivity: 62-1120 µmhos/cm (336 ± 35), Ca^{++}: 2-60 ppm (20 ± 2), and Na^{+}: 1-125 ppm (25 ± 5). Twenty-two Connecticut sites had values: pH: 5.7-8.9, conductivity: 24-319 µmhos/cm, Ca^{++}: 3-42 ppm, and Na^{+}: 1-2 ppm (Jokinen 1983). In North Dakota, water chemistry values were: pH: 7.6-8.9 (mean = 8.1, 8 sites), conductivity: 325-1500 µmhos/cm (880, 11 sites), and Ca^{++}: 95 ppm (one site) (Cvancara 1983). Sixteen sites in central New York had a pH range of 7.2-8.4 (8.4) (Harman & Berg 1971). In the Adirondack Mountains and surrounding lowlands, the distribution of *P. exacuous* is limited to sites with calcium greater than 9 ppm (Jokinen 1991). It appears that this species is only an occasional resident of acidic, low calcium habitats.

Family Ancylidae

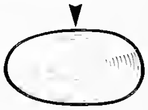
Shell cap-shaped, up to 10 mm long, without coiling; aperture subovate to subelliptical; foot large, oval; tentacles short, blunt, cylindrical; eyes sessile at tentacle base; jaw in three parts; animal sinistral; genital and breathing pores on left side (Baker 1928a, Basch 1963).

Key to the Ancylidae

1a. Tentacle cores black ....*Laevapex fuscus*

1b. Tentacle cores white...2

2a. Sides of shell nearly parallel ....*Ferrissia parallela*



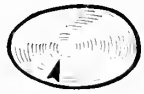
2b. Sides of shell not parallel...3

3a. Apex very off-center, almost to right edge of shell........ ....*Ferrissia walkeri*

3b. Apex centered or only slightly off-center......................4

4a. Apex centered, shell sturdy; usually restricted to flowing water ....*Ferrissia rivularis*

4b. Apex somewhat off-center, shell delicate; usually found in quiet waters ....*Ferrissia californica*



Laevapex fuscus (C.B. Adams, 1840)

Dusky ancylid

Figs. 27a, 28

Shell depressed, 6 mm long, oval or slightly obovate, tan, translucent; anterior slope straight or slightly curved; posterior slope slightly convex; right lateral slope straight; left lateral slope straight or slightly convex; apex obtuse, smooth, not rising above general contour of, and placed behind middle of, shell, somewhat to right; animal with distinct black pigment in tentacle cores (Baker 1928a, Basch 1959).

The anatomy of this species is described in detail by Basch (1959).

L. fuscus has a disjunct distribution. One population occurs in northwestern Ontario. The other is distributed from southern Ontario and Quebec south to Florida, and west to Minnesota, Oklahoma, Iowa, Kansas and Texas (Baker 1928a, Richards 1934, Dawley 1947, Basch 1963, McMahon & Aldridge 1976, Jokinen 1983, Thompson 1984a).

This species is only moderately common in New York. It occurs in the Hudson River watershed (212, 286, 292, 604), Mississippi-Ohio River watershed (431), St. Lawrence River watershed (259A, 263, 331, 332, 336, 337, 338, 339, 341, 409, 495, 497, 498, 500, 502A, 502B, 505, 524A, 531, 535), and the Susquehanna River watershed (400). It is absent from the Adirondack Mountains but common in the western lowlands (Jokinen 1991). Strayer (1987) noted a number of Hudson River basin sites, but Harman & Berg (1971) located only four sites in central New York.

Populations have been recorded from the lakes and waterfalls of the Mohawk River, Herkimer County (Lewis 1860); Schuyler's Lake, Otsego County (Lewis 1872); Tibbet's Brook, Riverdale, Bronx County (Prime 1880); Albany/Troy region, Albany and Rensselaer Counties, and the Normans Kill, Albany County (Marshall 1894, 1895); Flushing, Queens County, Long Island (Wheat 1907a); Oneida Lake, Oswego County (Baker 1916a, b; 1918a); Hudson River from Barrytown to Camelot, Dutchess County (Townes 1936); Sodus and Wolcott Creeks, Monroe County (Burdick 1939); Lake Mohegan, Peekskill, Westchester County; Flushing, Queens County, Long Island; Huntington, Suffolk County, Long Island (Jacobson & Emerson 1961); and Conesus Lake, Livingston County (Pinney & Coker 1934).

This species appears to be most common in still waters, such as impoundments, backwaters, ponds, and small lakes with a surface area of 10-100 hectares. On occasion it has been located in temporary habitats and rivers. Substrata are usually allochthonous organic matter, rocks, debris (such as bottles and cans), clam shells, and aquatic vegetation (water lilies, cattails, sedges, etc.) (Townes 1936, Dawley 1947, Basch 1963, Harman & Berg 1971, Jokinen 1983, Thompson 1984a, Strayer 1987). During this survey, populations were found at seven river and stream sites, 13 lake sites, three permanent ponds, two marshes, and a canal.

The snails feed on algal *Aufwuchs*, which vary in quality from habitat to habitat (McMahon *et al.* 1974). Temperate zone habitats with low productivity have snail populations with only one generation per year, slow maturation time, low fecundity (27 eggs/breeding season/adult), and long life span (over 400 days). In eutrophic, temperate zone habitats, there are two generations per year, the young grow rapidly, and egg production is high (70 eggs/adult). Longevity is 155 days for the spring generation and 320 days for the overwintering generation (McMahon 1975). A population in a small, eutrophic Connecticut lake had a generation that hatched in early July and, possibly, a second generation in autumn (Jokinen 1985). In warmer climates, such as occur in Texas, there can be as many as three generations per year (McMahon 1976). The snails

are not simultaneous hermaphrodites as is common with most pulmonates. They are protandric, with the timing of the sex change caused by water temperatures and/or habitat trophic differences (Russell-Hunter & McMahon 1976).

Laevapex fuscus is absent from low diversity habitats, tends to have low colonization rates, competes well, and has high tolerance for poor resources (Jokinen 1987).

Twenty-four sites in New York State located during this survey had the following water chemistry values: pH: 6.9-8.4 (7.4 ± 0.1), conductivity: 93-905 µmhos/cm (375 ± 39), Ca^{++}: 4-44 ppm (27 ± 3), and Na^{+}: 1-122 ppm (28 ± 7). In Connecticut, 25 sites had these values: pH: 5.8-7.6, conductivity: 30-319 µmhos/cm, Ca^{++}: 2-22 ppm, and Na^{+}: 1-18 ppm (Jokinen 1983). In the region of the Adirondack Mountains, *L. fuscus* is limited to lowlands in habitats of Ca^{++} values greater than 9 ppm (Jokinen 1991). In general, it appears to be absent from mountainous regions throughout its range (Basch 1963).

Ferrissia rivularis (Say, 1817)

Creeping ancylid
Figs. 27b, 28

Shell ovate, 7 mm long, pale tan; margins regularly curving; ends rounded; anterior slope convex; posterior slope concave below apex, but more or less straight near peritreme; right lateral slope slightly convex or straight; left lateral slope straight; apex subacute, well-elevated, inclining somewhat toward right, situated half of distance from posterior end, radially striate; peritreme flat; shell widest in front of apex, narrowing posteriorly (Baker 1928a).

The anatomy of this species was described by Hoff (1940).

F. rivularis occurs from New Brunswick and Maine west to Saskatchewan and California and south to North Carolina (Baker 1928a, Goodrich 1932, Richards 1934, Taylor 1981, Cvancara 1983, Jokinen 1983).

Ferrissia rivularis is fairly common in New York and occurs in the Delaware River watershed (471), Hudson River watershed (286, 287, 369, 380, 453, 600, 601, 615), Mississippi-Ohio River watershed (421, 425), St. Lawrence River watershed (307, 335, 343, 372, 375, 516, 517, 527), and the Susquehanna River watershed (391, 538, 539, 550, 554, 556, 557, 567, 583). It is common in the Hudson River and its upland streams (Strayer 1987) and in the Oswego and Susquehanna watersheds (Harman & Berg 1971).

Reports of this species in New York State have been relatively common, a number of them being listed under the synonym *Ancylus tardus* Say (see Basch (1963) for synonymies). Early records cite the Mohawk River and lakes of Herkimer and Otsego Counties (Lewis 1856b, 1860, 1872); Onondaga County (Beauchamp 1886b); Genesee River and Irondequoit Bay, Lake Ontario, Monroe County (Walton 1891); Ontario County (Marshall 1894); Albany/Troy region, Albany and Rensselaer Counties (Marshall 1895); Chautauqua Lake, Chautauqua County (Maury 1898, 1916; Townes 1937); Genesee River above first falls (Baker 1901); East Aurora, Erie County (Letson 1909); Cazenovia Lake, Madison County (Henderson 1907); Cayuga Lake, Cayuga and Seneca Counties (Maury 1916); Quaker Run, Allegany State Park, Cattaraugus County (Pinney & Coker 1934); and Findley Lake, Chautauqua County (Townes 1937).

This species almost always occurs in running water or river lakes (expansions of large rivers), although it does occur in lakes or ponds if the water is well-oxygenated. Preferred substrata are rocks, living and dead clam shells, submerged tree limbs, and debris such as bottles. Occasionally, snails are found on aquatic vegetation, such as cattails and lily pads (Goodrich 1932, Dawley 1947, Harman & Berg 1971, Taylor 1981, Cvancara 1983, Jokinen 1983, Strayer 1987). During this survey, *F. rivularis* was found at 23 river and stream sites, a lake, a river marsh, and three canals.

In temperate climates, the life history pattern of *F. rivularis* varies with the trophic richness of the habitat. In more eutrophic habitats, there are two generations per year. The spring generation lives for 11 months, and the summer generation lives for 3 months. Growth rates are high, and more eggs per limpet are laid. In the less eutrophic habitats, there is only one generation per year, longevity is 13 months, growth rates are slower, and each limpet produces fewer eggs (Burky 1971).

Water chemistry data for 27 sites surveyed in New York State are: pH: 6.1-8.2 (7.2 ± 0.1), conductivity: 56-530 µmhos/cm (268 ± 24); Ca^{++}: 1-50 ppm (18 ± 3), and Na^{+}: 1-45 ppm (14 ± 2). In Connecticut, ranges for 16 sites were: pH: 5.9-7.9, conductivity: 58-387 µmhos/cm, Ca^{++}: 2-26 ppm, and Na^{+}: 5-17 ppm (Jokinen 1983). North Dakota values were: pH: 7.9-9.3 (mean = 8.4, 52 sites), conductivity: 605-3150 µmhos/cm (1670, 25 sites), and Ca^{++}: 50-320 ppm (174, 33 sites) (Cvancara 1983). In the Adirondack region, *F. rivularis* inhabits waters in the western lowlands with high pH and calcium values (Jokinen 1991). In Connecticut and New York outside of the Adirondack Mountains, this species has a tolerance for low pH and low calcium, although it predominates in harder waters.

Ferrissia walkeri (Pilsbry & Ferriss 1907)

Cloche ancylid
Figs. 27c, 28

Shell moderately elevated, 5 mm long, thin, pale tan; anterior and lateral left slopes convex; posterior and lateral right slopes concave; apex depressed, radially striate, situated behind posterior third and much nearer right than left margin; peritreme oval (Pilsbry & Ferriss 1907).

The full distribution of this species is unknown. It occurs in Arkansas, Michigan, southern California, southern Oklahoma, Massachusetts, Vermont, and Connecticut (Basch 1963; Jokinen 1978b, 1983). It has not been reported from Canada (Clarke 1981).

F. walkeri was located at ten surveyed sites in the Delaware River watershed (466, 471), the Hudson River

watershed (367, 588), the St. Lawrence River watershed (396, 445C, 493, 533), and the Susquehanna River watershed (546, 577). Neither Strayer (1987) nor Harman & Berg (1971) found this species in eastern or central New York.

There appears to be no historical literature on this species in New York State.

Individuals can be found on rocks, glass bottles, and allochthonous submerged twigs and leaves. In New England, where they are rare, they are found in exceptionally clear, soft water lakes that harbor no other snail species (Jokinen 1978b, 1983). In New York, *F. walkeri* has been found at three river and stream sites, four lakes, one permanent pond, one temporary pond, and one canal.

Little is known about the life history of this species.

Water chemistry values for the 10 sites in New York State are: pH: 6.4-8.2 (7.1 ± 0.2), conductivity: 60-2320 μmhos/cm (585 ± 219), Ca^{++}: 1-89 ppm (24 ± 9), and Na^{+}: 1-291 ppm (56 ± 28). In southern New England, *F. walkeri* was found only in lakes of acidic, exceptionally soft water (Jokinen 1978b, 1983).

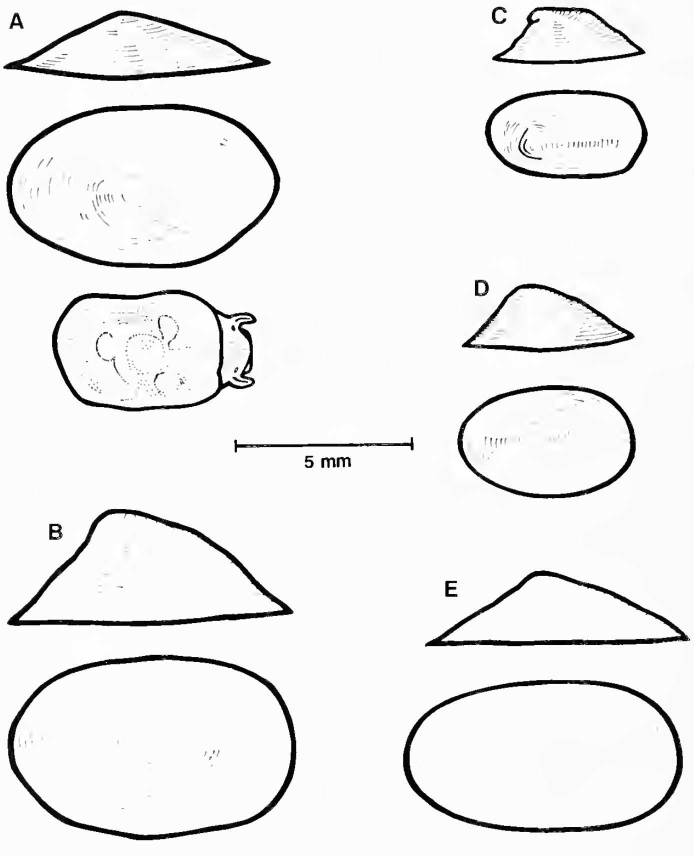


Fig. 27. Family Ancylidae, shells: a, *Laevapex fuscus*, lateral and dorsal views of shell and dorsal view of body showing black tentacle cores; b, *Ferrissia rivularis*; c, *F. walkeri*; d, *F. californica*; e, *F. parallela*. All shell illustrations are drawn to same scale.

Ferrissia californica (Rowell, 1863)

Fragile ancylid
Figs. 27d, 28

Shell small, fragile, 3.5 mm long, sometimes septate; sides nearly parallel, but diverging anteriorly; anterior slope convex; posterior slope concave; apex elevated, acute, curved backwards in midline or slightly to right, approximately 2/3 of shell length from anterior end (Tryon 1863, Clarke 1981).

Synonyms for *F. californica* are *F. fragilis* (Tryon), *F. novangliae* (Walker), and *F. shimekii* (Pilsbry).

In Canada, this species has been recorded from southwest British Columbia, Quebec, and southern Ontario (Clarke 1981). Farther south, populations have been recorded from New England to Maryland and Kentucky, southwest to northern Mexico and California (Leonard 1959, McMahon & Aldridge 1976, Gerberich 1981, Taylor 1981, Jokinen 1983, Branson *et al.* 1987, Blinn *et al.* 1989). Although Basch (1963) referred to *F. hendersoni* Walker as a subspecies of *F. californica*, Thompson (1984a) separated the two into distinct species, with *F. californica* occurring north of North Carolina and *F. hendersoni* occurring from North Carolina to Florida. It is not known if Beetle's (1968) Ocracoke Island, North Carolina, location is for *F. californica* or *F. hendersoni*.

During this survey, this species was found scattered throughout New York State in the Hudson River watershed (269, 276, 277, 293, 317, 318, 383, 384, 459, 602), the St. Lawrence River watershed (279, 280, 332, 341, 354, 402, 409, 412, 436, 439, 502B, 524B), the Susquehanna River watershed (571), and the Atlantic coastal drainages (253). Harman & Berg (1971) did not report it from central New York, but Strayer (1987) located it in the Hudson River basin.

Marshall (1893) recorded *F. californica* from Canandaigua Lake, Ontario County.

This species prefers the quiet waters of lakes, ponds, and ditches, but it occasionally lives in slowly flowing streams. It is common on allochthonous organic material, aquatic plants, such as cattails and pond lilies, and occasionally rocks (Jokinen 1978b, 1983; Clarke 1981; Taylor 1981). During this survey, populations were found in three river and stream sites, 10 lakes, 10 ponds, and a marsh.

A study in Arizona showed that *F. californica* individuals are first active in early April, when they can be found on the undersides of lily pads (*Nuphar luteum polysepalum* (Engelm.) E.O. Beal). The snails exhibit negative phototaxis; when the lily pads are turned over, they migrate to the lower surfaces. Average densities were 112 snails/m^2. By early November the snails disappear from the lily pads and are found among the fibrous roots of *Carex senta* Boott. Diet consists primarily of closely adnate diatoms, including *Epithemia* spp. and *Cocconeis* spp. Ribbon-like chains of *Synedra* sp. and *Nitzchia* sp. are not ingested (Blinn *et al.* 1989).

In an eutrophic Connecticut lake, *F. californica* appears to have a bivoltine or trivoltine reproductive pattern with eggs produced during two or three periods: late May,

Fig. 28. Known distribution of species of Ancylidae in New York State. Closed circles indicate records from the present survey, and open circles indicate records from museum specimens.

early August, and mid September (Jokinen 1985). In the northeastern United States, *F. californica* is ubiquitous in habitats of low to high snail diversity, but it is less frequently found in those with high diversity (Jokinen 1987).

Water chemistry values for 23 New York State sites studied during this survey are: pH: 5.8-8.2 (7.2 ± 0.1), conductivity: 28-1755 µmhos/cm (340 ± 74), Ca^{++}: 2-74 ppm (23 ± 4), and Na^{+}: 1-122 ppm (17 ± 6). Values for 46 Connecticut sites are: pH: 5.1-7.5, conductivity: 38-346 µmhos/cm, Ca^{++}: 1-27 ppm, and Na^{+}: 1-40 ppm (Jokinen 1983). This species occurs at all altitudes and in all types of water in the region of the Adirondack Mountains and surrounding lowlands (Jokinen 1991).

Ferrissia parallela (Haldeman, 1841)
Oblong ancylid
Figs. 27e, 28

Shell narrow, elongate, 8 mm long, pale tan; lateral margins nearly straight; ends well-rounded; anterior slope long, slightly convex; posterior slope shorter than anterior, straight to slightly concave; right lateral slope nearly straight; left lateral slope slightly convex; shell radially striate; apex subacute, slightly turned toward right, slightly anterior of shell center (Baker 1928a).

In Canada, this species occurs from Newfoundland and Prince Edward Island west to southern Manitoba (Clarke 1981). In the United States, it ranges from New England west to Minnesota and, possibly, North Dakota; it appears to be limited to the northern tier of states (Baker 1928a, Dawley 1947, Basch 1963, Cvancara 1983, Jokinen 1983).

Ferrissia parallela is relatively common in New York State but appears to be limited to the northern sections of the watersheds: Hudson River watershed (270, 273, 300, 304, 385, 386); Mississippi-Ohio River watershed (415); St. Lawrence River watershed (141C, 260, 262, 263, 308, 336, 349, 351, 357, 361, 448B, 449, 450, 498, 515, 518B, 524A, 534); and Susquehanna River watershed (536, 574, 579, 581, 582). Strayer (1987) noted its presence in the Hudson River basin, and Harman & Berg (1971) found it scattered throughout central New York.

This species has been reported from Herkimer County (Lewis 1860); Schuyler's Lake, Otsego County (Lewis 1872); Riverdale, Bronx County (Prime 1880); Onondaga County (Beauchamp 1886b); Charlotte, Monroe County (Walton 1891); Little Lakes, Herkimer County, and the Normans Kill, Albany, Albany County (Marshall 1894); Albany/Troy region, Albany and Rensselaer Counties (Marshall 1895); "Chippawa" (Letson 1909); Fall Creek, Ithaca, Tompkins County, and Cayuga Lake, Cayuga and Seneca Counties (Maury 1916); Oneida Lake, Oswego and Onondaga Counties (Baker 1916a, b; 1918a; Pratt 1923; Harman & Berg 1970; Sodus Bay, Wayne County, and Little Sodus Bay, Cayuga County, Lake Ontario (Burdick 1939); woodland pond near Annsville, Westchester County (Jacobson & Emerson 1961); Canandarago Lake, Otsego County (Harman 1973); Moe Pond, Otsego County (MacNamara & Harman 1975); and Lewis, Oneida, and Jefferson Counties (Buckley 1977).

F. parallela usually is found in permanent, quiet waters, and it is associated with aquatic vegetation, including *Oedogonium*, *Cladophora*, *Nymphaea*, *Nuphar*, *Castalia*, *Typha*, *Scirpus*, *Vallisneria*, *Potamogeton*, *Zinzania*, and *Sparganium* spp. in water 0.5-11.0 m deep (Baker 1918a, 1928a; Dawley 1947; Basch 1963; Harman & Berg 1971; Harman 1972; Jokinen 1983). During this survey, this species was located in four river and stream sites, 12 lakes, seven permanent ponds, two ditches, three marshes, and two canals.

Little appears to be known about the life history of this species. *F. parallela* is ubiquitous in habitats of different diversities (Jokinen 1987).

Water chemistry values for 26 New York State sites studied during this survey are: pH: 6.0-8.0 (7.0 ± 0.1), conductivity: 33-760 µmhos/cm (204 ± 35), Ca^{++}: 2-44 ppm (15 ± 2), and Na^{+}: 1-122 ppm (16 ± 6). For 11 sites in Connecticut, values are: pH: 6.2-7.6; conductivity: 31-319 µmhos/cm, Ca^{++}: 2-35 ppm, and Na^{+}: 2-18 ppm (Jokinen 1983). In central New York (Harman & Berg 1971), pH values ranged from 7.3-8.1 (mean = 7.7). For the Adirondack Mountains and associated lowlands, *F. parallela* is ubiquitous relative to altitude and water chemistry (Jokinen 1991).

GLOSSARY

adnate - grown together.

aestivation - a period of dormancy in the summer when ponds or streams dry up.

allochthonous - having an external origin (e.g., allochthonous organic matter in a lake consists of terrestrial leaf litter and branches that have fallen into the lake).

AMNH - American Museum of Natural History, New York City.

aperture - opening, or mouth, of shell.

apex - tip of shell, pointed in most species.

Aufwuchs - see periphyton.

auriculate - ear-like in shape.

autochthonous - having an internal origin (e.g., autochthonous organic matter in a lake consists of aquatic vegetation and its remains).

Barge Canal - the reconstructed Erie Canal system, plus the Champlain Canal.

bifid - divided into two lobes.

bifurcate - divided into two branches.

biomass - the weight of living material within an area; the higher the biomass, the higher the productivity.

bivoltine - having two generations per year.

body whorl - last whorl of a spiral shell, containing the aperture.

Ca^{++} - calcium ion concentration in solution, usually measured as parts per million (ppm) or milligrams per liter (mg/l); soft water has less than 5 ppm dissolved calcium.

callus - deposit of shelly material that covers inner lip or columellar region of shell.

campanulate - shaped like a bell.

canaliculate - channeled or grooved.

carinate - keeled or ridged.

channeled - grooved or formed like a channel.

chink - a narrow opening; in shells, it refers to a slit-like umbilicus.

collabral - conforming to shape of the outer lip at an earlier growth stage as shown by growth lines.

columella - the centrally located pillar surrounding the axis of coiling of a spiral shell.

conductivity or specific conductance - the ability of a solution to conduct an electrical current, measured in micromhos per centimeter (µmhos/cm). High conductivity results from high dissolved ion concentration.

corneous - consisting of a horny substance.

decollated - "beheaded" or cut off, like the apex of some shells.

dentate - with points or nodules resembling teeth.

detritus - dead organic matter and its associated microbes.

dextral - coiled to the right (opposite of sinistral). When held with the apex up and the aperture facing the viewer, the aperture of a dextral shell is on the right side.

dioecious - having male reproductive organs in one individual and female in another.

discoidal - shaped like a flat disc.

distal - far from a point of origin or attachment (opposite from proximal).

emarginate - bluntly notched.

escarpment - land form consisting of a precipitous face of a ridge.

eutrophic - rich in nutrients, especially phosphorus.

expanded - spread out, as the lip of some shells.

filiform - thread-like.

fusiform - tapering from the middle toward each end.

gelatinous - jelly-like.

globose - inflated and approaching the shape of a sphere.

habitat - type of site where a species normally lives and grows.

hardness - quality of water that prevents soap from dissolving; primarily caused by high calcium and magnesium ion concentrations.

herbivorous - feeding on plants.

hermaphrodite - an individual having both male and female reproductive organs.

hirsute - appearing hairy.

imperforate - not perforated or umbilicated.

impressed - marked by a furrow.

inflated - swollen, enlarged.

iteroparous - having more than one reproductive season, as in viviparid snail species that can produce several broods in a lifetime.

keeled - with a more or less sharp projection at the periphery.

lacrimate - shaped like a tear drop.

lamellae - thin plates or blade-like ridges.

lentic habitats - standing waters, such as lakes and ponds.

limpet - a snail with a noncoiled shell variously peaked to flattened

lip - rim of aperture.

littoral - the shallow, near-shore region of a body of water, often defined as the band from zero depth to the edge of the rooted-plant zone.

lotic habitats - running waters, such as streams and rivers.

macrophytic vegetation - rooted aquatic plants.

malleated - appearing as if shaped by hammering.

mantle - fleshy tissue that secretes the molluscan shell and lies against its inner surface.

marl - earthy lake or river deposit consisting of clay and calcium carbonate.

monoecious - hermaphroditic, with the sexes united in one individual.

multispiral - consisting of many whorls.

multivoltine - pertaining to populations having more than three generations per year.

MCZ - Museum of Comparative Zoology, Harvard University.

Na^+ - sodium ion concentration in solution, usually measured in parts per million (ppm) or milligrams per liter (mg/l); most inland waters in New York State have low salinity, less than 5 ppm sodium.

notched - nicked or indented, like the anterior canal of some snails.

nucleus - the first whorl, or nuclear whorl, of a spiral shell.

NYSM - New York State Museum, Albany.

oblique - slanting, like the apertures of some shells that are not parallel to the longitudinal axis.

obovate - ovate with a narrow end at the base

obtuse - dull or blunt, like the apex of some shells, with the angle exceeding 90 degrees.

operculate - having an operculum.

operculum - horny or shelly, plate-like structure attached to the foot of most prosobranch snails. It seals the shell aperture when the animal is contracted within.

orbicular - circular, disc-like.

outer lip - the portion of the lip on the right side of the aperture of a dextral shell or the left side of the aperture of a sinistral shell.

ovately conic - shaped like an egg, but with a somewhat conical apex.

oviparous - bringing forth young in an egg that hatches after it is laid.

ovoviviparous - bringing forth young in an egg that hatches before it is laid.

parietal - the part of the aperture adjacent to the preceding whorl.

parthenogenic - capable of reproduction without fertilization of eggs.

patelliform - shaped like a flattened-out cone; obtusely conic.

paucispiral - consisting of few spirals or less than one complete spiral.

pellucid - transparent or clear.

penultimate whorl - the whorl preceding the last, or body, whorl.

periostracum - the organic outer layer of the shell.

periphyton - the biota attached to submerged surfaces; the community of sessile, or attached, organisms on lake and stream plants, rocks, etc.

peristome - lip.

peritreme - outer rim of a limpet shell.

pH - a measure of acidity or alkalinity of a solution (values 1-6 indicate decreasing acidity, 7 is neutral, and values 8-14 indicate increasing alkalinity).

phenotypic plasticity - the capacity of a species to respond to an environment physically or physiologically without genetic change.

plait - a spiral, flattened ridge on the columella.

planorboid - flat and orb-like, coiled approximately in a single-plane.

planospiral - coiled in a single plane.

prosobranchs - gill-breathing, operculate, and usually dioecious snails of the subclass Prosobranchia.

proximal - nearest end of an object (opposite from distal).

pseudobranch - a secondary gill formed from an extension of the mantle in some pulmonate snails.

pulmonates - "lung" breathing, nonoperculate, monoecious snails of the subclass Pulmonata.

radiating - extending from a common center.

reflected - bent back, like the lip of some snails.

retractile - capable of being drawn in.

rimate - provided with a small hole or crack, like the place where an umbilicus is very narrowly open.

semelparous - having only one reproductive period, usually with a large number of offspring, during a life span.

septate - with one or more internal, shelly partitions.

sessile - attached without a stem.

shouldered - shaped like a shoulder, with a flattened upper surface bounded by a definite angle.

sinistral - coiled to the left (opposite of dextral). When held with apex up and aperture toward the viewer, the aperture of a sinistral shell is on the left side.

spire - the upper portions of spiral shells from above body whorl to the apex.

spire angle - angle at the apex formed by the cone of the spire.

sp. - abbreviation for species (singular).

spp. - abbreviation for species (plural).

striae - impressed lines or narrow grooves.

striated - marked by lines or striae.

subangulated - moderately angled.

subcarinated - moderately carinated.

subconical - moderately conical.

subcylindrical - moderately cylindrical.

subglobose - moderately globose.

sulcated - grooved

suture - external juncture line between adjacent shell whorls.

trifid - separated into three lobes.

trivoltine - having three generations per year.

truncate - terminating abruptly, appearing as if cut squarely off.

turbinate - having the form of a top.

turreted - having whorls forming a high conical spiral.

ultradextral - anatomically sinistral, but appearing dextral because of the angle at which the shell is held.

umbilicated - with a wide umbilicus.

umbilicus - the opening at the base of a shell, opposite the spire; the hollow center, if present, of the axis of rotation of a shell.

univoltine - having one generation per year.

varix - a thickened mark on the surface of a shell at a former position of the aperture lip during a period of arrested growth.

vernal - occurring in the spring.

verge - in some snails, an organ of the male genital tract that bears the penis.

volution - a complete turn of a spiral shell; a whorl.

whorl - a single complete turn of a spiral shell, a volution.

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APPENDIX A. COLLECTION SITES

The numbers of the following sites are the original numbers assigned by the author and surveyor. Omitted numbers are assigned to collections made outside New York State. The following abbreviations are used: Bk. - Brook; Co. - County; Cr. - Creek; E - East(ern); km - kilometer(s); L. - Lake; m - meter(s); N - North(ern); Pd. - Pond; R. - River; Rd. - Road; Rte. - Route; S - South(ern); St. - Street; T.M. - Topographic map; Twp. - Township; W - West(ern).

96A. Hudson R., river mile 82, West Park, Esopus Twp., Ulster Co., Hyde Park T.M. 7.5′ (1963), Hudson R. watershed.

96B. Hudson R., river mile 90, Sturgeon Point, Rhinecliff Twp., Dutchess Co., Kingston East T.M. 7.5′ (1980), Hudson R. watershed.

96C. Hudson R., river mile 98, Turkey Point, S of Glasco, Saugerties Twp., Ulster Co., Saugerties T.M. 7.5′ (1963), Hudson R. watershed.

96D. Hudson R., river mile 139, S of Van Wies Point, across river from Staats Point, Bethlehem Twp., Albany Co., Delmar T.M. 7.5′ (1980), Hudson R. watershed.

96E. Hudson R., river mile 140, across river from Van Wies Point, East Greenbush Twp., Rensselaer Co., Delmar T.M. 7.5′ (1980), Hudson R. watershed.

96F. Hudson R., river mile 140, Van Wies Point, Bethlehem Twp., Albany Co., Delmar T.M. 7.5′ (1980), Hudson R. watershed.

96G. Hudson R., river mile 145, S of Lower Patroon Island., Rensselaer, East Greenbush Twp., Rensselaer Co., Troy South T.M. 7.5′ (1980), Hudson R. watershed.

96H. Hudson R., river mile 149, S of Rte. 2, across from Breaker Island, Troy Twp., Rensselaer Co., Troy South T.M. 7.5′ (1980), Hudson R. watershed.

96I. Hudson R., river mile 148, across from S end of Breaker Island, North Greenbush Twp., Rensselaer Co., Troy South T.M. 7.5′ (1980), Hudson R. watershed.

141A. L. Champlain, Kelly Bay Access, Alburg Twp., Grand Isle Co., Vermont, Rouses Point T.M. 7.5′ (1966), St. Lawrence R. watershed.

141B. L. Champlain, Dillenbeck Bay Access, Alburg Twp., Grand Isle Co., Vermont, Rouses Point T.M. 7.5′ (1966), St. Lawrence R. watershed.

141C. L. Champlain, base of bridge at South Alburg Twp., Grand Isle Co., Vermont, Rouses Point T.M. 7.5′ (1966), St. Lawrence R. watershed.

141D. L. Champlain, N of bridge near Knight Point, North Hero Twp., Grand Isle Co., Vermont, North Hero T.M. 7.5′ (1966), St. Lawrence R. watershed.

212. Gleneida L., Carmel Twp., Putnam Co., Lake Carmel T.M. 7.5′ (1981), Hudson R. watershed.

250. Pond, unnamed, SE of Hay Harbor, Fishers Island, Southold Twp., Suffolk Co., Mystic T.M. 7.5′ (1958), Atlantic Coastal drainage.

251. Middle Farms Pd., Fishers Island, Southold Twp., Suffolk Co., Mystic T.M. 7.5′ (1958), Atlantic Coastal drainage.

252. Pond, unnamed, East Harbor Golf Course, W of road, 0.1 km WSW of clubhouse, Fishers Island, Southold Twp., Suffolk Co., Mystic T.M. 7.5′ (1958), Atlantic Coastal drainage.

253. Pond, unnamed, East Harbor Golf Course, W of road, 0.15 km SW of clubhouse, Fishers Island, Southold Twp., Suffolk Co., Mystic T.M. 7.5′ (1958), Atlantic Coastal drainage.

254. Money Pd., near East Point, S of road, Fishers Island, Southold Twp., Suffolk Co., Mystic T.M. 7.5′ (1958), Atlantic Coastal drainage.

259A. Dead Cr., W of Rte. 9, Plattsburgh Twp., Clinton Co., Plattsburgh T.M. 7.5′ (1966), St. Lawrence R. watershed.

259B. Dead Cr., W of Rte. 9, Plattsburgh Twp., Clinton Co., Plattsburgh T.M. 7.5′ (1966), St. Lawrence R. watershed.

260. L. Champlain, Ausable Marsh State Game Reserve Area, N of Dead Cr. inlet, Peru Twp., Clinton Co., Keeseville T.M. 7.5′ (1966), St. Lawrence R. watershed.

261. L. Champlain, Municipal Beach, 0.7 km SE of intersection of Rtes. 9 & 314, Plattsburg Twp., Clinton Co., Plattsburgh T.M. 7.5′ (1966), St. Lawrence R. watershed.

262. Dead Cr. Marsh, Ausable Marsh State Game Reserve Area, Peru Twp., Clinton Co., Keeseville T.M. 7.5′ (1966), St. Lawrence R. watershed.

263. Dead Cr., at L. Champlain, Plattsburgh Twp., Clinton Co., Plattsburgh T.M. 7.5′ (1966), St. Lawrence R. watershed.

264. L. Champlain, Grand Isle Ferry Dock, Cumberland Head, Plattsburgh Twp, Clinton Co., Plattsburgh T.M. 7.5′ (1966), St. Lawrence R. watershed.

265. Saratoga L., Saratoga Lake Village, E foot of Rte. 9P, State Boat Launch, Saratoga Twp., Saratoga Co., Quaker Springs T.M. 7.5′ (1967), Hudson R. watershed.

266. Polaris Spring, *Typha* ditch, Saratoga Spa State Park, Saratoga Springs Twp., Saratoga Co., Saratoga Springs T.M. 7.5′ (1967), Hudson R. watershed.

267. Geyser Bk., Hayes Spring in Saratoga Spa State Park, at geyser, Saratoga Springs Twp., Saratoga Co., Saratoga Springs T.M. 7.5′ (1967), Hudson R. watershed.

268. Kayaderosseras Cr., unnamed tributary, E entrance road, Saratoga Spa State Park, 100 m E of toll gate, Saratoga Springs Twp., Saratoga Co., Saratoga Springs T.M. 7.5′ (1967), Hudson R. watershed.

269. Geyser Bk., *Typha* marsh, NW of Geyser Rd. (Adams Rd.) & Rte. 50, Saratoga Springs Twp., Saratoga Co., Saratoga Springs T.M. 7.5′ (1967), Hudson R. watershed.

270. Crook Brook Pd., E of cemetery, SE of East Galway Village, Galway Twp., Saratoga Co., Middle Grove T.M. 7.5′ (1967), Hudson R. watershed.

271. Ludlow Swamp, impoundment of Glowegee Cr., Rte. 147, N of Alexander Rd., Galway Twp., Saratoga Co., Galway T.M. 7.5′ (1970), Hudson R. watershed.

272. Galway L. (Amsterdam Reservoir), N shore on Lake Rd., Galway Twp., Saratoga Co., Galway T.M. 7.5′ (1970), Hudson R. watershed.

273. Thirteenth L., E shore, Garnet Hill Lodge beach access, Johnsburg Twp., Warren Co., Thirteenth Lake T.M. 15.0′ (1954), Hudson R. watershed.

274. Raquette Bk., unnamed beaver pond, Rte. 28, 4 km W of Hudson R., Indian Lake Twp., Hamilton Co., Newcomb T.M. 15.0′ (1954), Hudson R. watershed.

275. Beaver Meadow Bk., unnamed tributary, Rte. 28, 6 km E of L. Abanakee, Indian Lake Twp., Hamilton Co., Newcomb T.M. 15.0′ (1954) Hudson R. watershed.

276. L. Abanakee, NW shore, Rte. 28 at Indian Lake Water Dept. inlet stream, Chain Lakes Rd., Indian Lake Twp., Hamilton Co., Newcomb T.M. 15.0′ (1954), Hudson R. watershed.

277. L. Durant, N shore, Rtes. 28 & 30, 4 km E of Blue Mountain Lake Village, Indian Lake Twp., Hamilton Co., Blue Mountain T.M. 15.0′ (1954), Hudson R. watershed.

278. Mirror L., W shore, Lake Placid Village, North Elba Twp., Essex Co., Lake Placid T.M. 15.0′ (1953), St. Lawrence R. watershed.

279. Barber Pd., impoundment of Phelps Cr., Rte. 9, 5 km N of Rte. 9N, Elizabethtown Twp., Essex Co., Elizabethtown T.M. 15.0′ (1955), St. Lawrence R. watershed.

280. Pumping Station Pd., Rte. 9, 1 km S of Rte. 9N, across road from cemetery, Elizabethtown Twp., Essex Co., Elizabethtown T.M. 15.0′ (1955), St. Lawrence R. watershed.

281. L. Champlain, North West Bay, Westport Twp., Essex Co., Port Henry T.M. 15.0′ (1945), St. Lawrence R. watershed.

282. Paradox Cr. backwater, 1 km W of Flemings Pd., Hamlet of Paradox, Schroon Twp., Essex Co., Paradox Lake T.M. 7.5′ (1973), Hudson R. watershed.

283. Flemings Pd., 1.5 km NE of Hamlet of Paradox, Letsonville Rd., Schroon Twp., Essex Co., Paradox Lake T.M. 7.5′ (1973), Hudson R. watershed.

284. Paradox L., Dark Bay, Rte. 74, 5 km E of Severance, State Boat Launch, Schroon Twp., Essex Co., Paradox Lake T.M. 7.5′ (1973), Hudson R. watershed.

285. Cemetery Pd., Rte. 74, 2 km W of Severance, Schroon Twp., Essex Co., Pharaoh Mountain T.M. 7.5′ (1973), Hudson R. watershed.

286. Hudson R., North Bay, Tivoli Marshes, Red Hook Twp., Dutchess Co., Saugerties T.M. 7.5′ (1963), Hudson R. watershed.

287. Saw Kill, stream and mill pond, Bard College Ecology Field Station, Annandale-on-Hudson, Red Hook Twp., Dutchess Co., Saugerties T.M. 7.5′ (1963), Hudson R. watershed.

288. Saw Kill, unnamed tributary impoundment, Rte. 199, 0.5 km E of Echo Valley Rd., Red Hook Twp., Dutchess Co., Rock City T.M. 7.5′ (1963), Hudson R. watershed.

289. Wilbur Pd., W shore, Rte. 199, 2 km NE of Lafayetteville, Lafayette Multiple Use Area, Milan Twp., Dutchess Co., Pine Plains T.M. 7.5′ (1960), Hudson R. watershed.

290. Thompson Pd., N shore, Lake Rd., Pine Plains Twp., Dutchess Co., Pine Plains T.M. 7.5′ (1960), Hudson R. watershed.

291. Stissing Pd., SE shore, Lake Rd., Pine Plains Twp., Dutchess Co., Pine Plains T.M. 7.5′ (1960), Hudson R. watershed.

292. L. Taghkanic, Lake Taghkanic State Park, Gallatin Twp., Colombia Co., Ancram T.M. 7.5′ (1960), Hudson R. watershed.

293. Queechy L., NW shore, Lake Drive, Canaan Twp., Columbia Co., Canaan T.M. 7.5′ (1973), Hudson R. watershed.

294. Beebe Pd., Canaan Twp., Columbia Co., Canaan T.M. 7.5′ (1973), Housatonic R. watershed.

295. Barrett Pd., Beebe Hill State Forest, Austerlitz Twp., Columbia Co., State Line T.M. 7.5′ (1973), Hudson R. watershed.

297. Moreau L., Moreau Lake State Park, Moreau Twp., Saratoga Co., Gansevoort T.M. 7.5′ (1968), Hudson R. watershed.

298. Crandall Park Pd., Crandall Park, Glens Falls, Queensbury Twp., Warren Co., Glens Falls T.M. 7.5′ (1966), St. Lawrence R. watershed.

299. Glens Falls Feeder Canal, Rte. 9, Glens Falls, Queensbury Twp., Warren Co., Glens Falls T.M. 7.5′ (1966), Hudson R. watershed.

300. Pumping Station Pd., pumping station, Bluebird Rd., Fernwood Village, Moreau Twp., Saratoga Co., Glens Falls T.M. 7.5′ (1966), Hudson R. watershed.

301. Hudson R., at pumping station, Bluebird Rd., Fernwood Village, Moreau Twp., Saratoga Co., Glens Falls T.M. 7.5′ (1966), Hudson R. watershed.

302. Pond, unnamed, East River Dr., 1 km SE of Rte. 9N, Lake Luzerne Village, Lake Luzerne Twp., Warren Co., Lake Luzerne T.M. 7.5′ (1968), Hudson R. watershed.

303. L. Luzerne, W shore, Rte. 9N, boat launch site, Lake Luzerne Twp., Warren Co., Lake Luzerne T.M. 7.5′ (1968), Hudson R. watershed.

304. Stewart Bk., Lake Tour Rd. bridge, Lake Luzerne Village, Lake Luzerne Twp., Warren Co., Lake Luzerne T.M. 7.5′ (1968), Hudson R. watershed.

305. Fourth L., Fourth Lake State Park, Lake Luzerne Twp., Warren Co., Lake Luzerne T.M. 7.5′ (1968), Hudson R. watershed.

306. Pond, unnamed, Lake George Beach State Park, across road from S shore of L. George, Lake George Twp., Warren Co., Lake George T.M. 7.5′ (1966), St. Lawrence R. watershed.

307. Little Chazy R., Stetson Rd., 2.5 km NW of Chazy Village, Chazy Twp., Clinton Co., Champlain T.M. 7.5′ (1966), St. Lawrence R. watershed.

308. Great Chazy R., railroad bridge on Lake Shore Rd., 1 km SE of Coopersville, Champlain Twp., Clinton Co., Champlain T.M. 7.5′ (1966), St. Lawrence R. watershed.

309. L. Alice, Lake Alice State Game Management Area, Chazy Twp., Clinton Co., Beekmantown T.M. 7.5′ (1966), St. Lawrence R. watershed.

310. Great Chazy R., Feinberg Park, Altona Twp., Clinton Co., Altona T.M. 7.5′ (1966), St. Lawrence R. watershed.

311. Chazy L., W shore, Seine Bay, Dannemora Twp., Clinton Co., Ellenberg Mountain T.M. 7.5′ (1964), St. Lawrence R. watershed.

312. Hudson-Champlain Canal, Rte. 4, 2 km S of Comstock, Fort Ann Twp., Washington Co., Fort Ann T.M. 7.5′ (1944), St. Lawrence R. watershed.

313. Bog, unnamed, W of Hudson-Champlain Canal, W side of Rte. 4, 2 km S of Comstock, Fort Ann Twp., Washington Co., Fort Ann T.M. 7.5′ (1944), St. Lawrence R. watershed.

314. Pond, unnamed, W side of Rte. 4, E of railroad tracks, 1.2 km S of Comstock, Fort Ann Twp., Washington Co., Fort Ann T.M. 7.5′ (1944), St. Lawrence R. watershed.

315. Mettawee R., bridge at North Granville, Granville Twp., Washington Co., Granville T.M. 7.5′ (1944), St. Lawrence R. watershed.

316. Rathbun Pd., Pine Hill Rd., 1.5 km N of Granville Village, Granville Twp., Washington Co., Granville T.M. 7.5′ (1944), St. Lawrence R. watershed.

317. Chamberlain Mills Pd., impoundment of Black Cr., 1.5 km W of East Hebron, Hebron Twp., Washington Co., West Pawlet T.M. 7.5′ (1944), Hudson R. watershed.

318. L. Cossayuna Outlet Pd., at Veterans Memorial, Cossayuna Village, Greenwich Twp., Washington Co., Cossayuna T.M. 7.5′ (1944), Hudson R. watershed.

319. Cossayuna L., Argyle Twp., Washington Co., Cossayuna T.M. 7.5′ (1944), Hudson R. watershed.

320. Carter Pd., 2 km S of Cossayuna Village, Rte. 338, Carter Pond Conservation Area, Greenwich Twp., Washington Co., Cossayuna T.M. 7.5′ (1944), Hudson R. watershed.

321. Mill Pd., Grafton Lakes State Park, Grafton Twp., Rensselaer Co., Grafton T.M. 7.5′ (1954), Hudson R. watershed.

322. Swamp, unnamed, S of Silver L., North Rd., Greenport, Long Island, Southold Twp., Suffolk Co., Greenport T.M. 7.5′ (1956), Atlantic Coastal drainage.

331. Rutland L., N shore, Rte. 126, Rutland Twp., Jefferson Co., Rutland Center T.M. 7.5′ (1959), St. Lawrence R. watershed.

332. Rutland Gorge Stream, Ridge Rd., Huntingtonville Village, Rutland Twp., Jefferson Co., Rutland Center T.M. 7.5′ (1959), St. Lawrence R. watershed.

333. Black R., Ridge Rd., 3 km E of Weaver Rd., Huntingtonville Village, Rutland Twp., Jefferson Co., Rutland Center T.M. 7.5′ (1959), St. Lawrence R. watershed.

334. Black R., 0.3 km E of Rte. 3, across from Delano Island, Huntingtonville Village, Rutland Twp., Jefferson Co., Rutland Center T.M. 7.5' (1959), St. Lawrence R. watershed.

335. Black R., unnamed tributary, 0.3 km E of Rte. 3, Huntingtonville Village, Rutland Twp., Jefferson Co., Rutland Center T.M. 7.5' (1959), St. Lawrence R. watershed.

336. Perch L., W end of spillway, Perch River Wildlife Management Area, Brownville Twp., Jefferson Co., Brownville T.M. 7.5' (1982), St. Lawrence R. watershed.

337. Chaumont R. Impoundment, Rte. 180, La Fargeville Twp., Jefferson Co., La Fargeville T.M. 7.5' (1958), St. Lawrence R. watershed.

338. Butterfield L., S shore, State Boat Launch, Redwood Village, Alexandria Twp., Jefferson Co., Redwood T.M. 7.5' (1982), St. Lawrence R. watershed.

339. Black L., W shore, public boat launch, Black Lake Rd., 1.6 km S of Rte. 58, Edwardsville Twp., St. Lawrence Co., Edwardsville T.M. 7.5' (1963), St. Lawrence R. watershed.

340. St. Lawrence R., 0.2 km S of Nevins Point, Oswegatchie Twp., St. Lawrence Co., Ogdensburg West T.M. 7.5' (1963), St. Lawrence R. watershed.

341. Oswegatchie R., Eelwier State Park, Oswegatchie Twp., St. Lawrence Co., Ogdensburg East T.M. 7.5' (1963), St. Lawrence R. watershed.

342. Brown Church Road Pd., Brown Church Rd., Waddington Twp., St. Lawrence Co., Sparrowhawk Point T.M. 7.5' (1963), St. Lawrence R. watershed.

343. St. Lawrence R., embayment 1.3 km SE of Iroquois Dam, 0.5 km E of Browns Church Rd., Waddington Twp., St. Lawrence Co., Sparrowhawk Point T.M. 7.5' (1963), St. Lawrence R. watershed.

344. Grass R., E of bridge on Louisville Rd., Louisville Village, Louisville Twp., St. Lawrence Co., Louisville T.M. 7.5' (1964), St. Lawrence R. watershed.

345. Raquette R., N. Raquette River Rd., 0.6 km E of Haverstock, Massena Twp., St. Lawrence Co., Raquette River T.M. 7.5' (1964), St. Lawrence R. watershed.

346. St. Regis R., McIntyre Rd., 2 km NE of Helena Village, Brasher Twp., St. Lawrence Co., Hogansburg T.M. 7.5' (1964), St. Lawrence R. watershed.

347. Malone Memorial Recreation Park Pd., Malone Memorial Recreation Park, Malone Twp., Franklin Co., Malone T.M. 7.5' (1964), St. Lawrence R. watershed.

348. Lamica L., impoundment of Salmon R., at Cady Rd. bridge, Malone Twp., Franklin Co., Constable T.M. 7.5' (1964), St. Lawrence R. watershed.

349. Lower Chateaugay L., at dam, The Forge, Chateaugay Twp., Franklin Co., Brainardsville T.M. 7.5' (1964), St. Lawrence R. watershed.

350. Chateaugay Narrows, Rte. 374 at Shutts Rd., Upper Chateaugay Department of Environmental Conservation State Boat Launch, Ellenburg Twp., Clinton Co., Ellenburg Center T.M. 7.5' (1964), St. Lawrence R. watershed.

351. Lyon Mountain Pd., Rte. 374, Lyon Mountain Village, Dannemora Twp., Clinton Co., Lyon Mountain T.M. 7.5' (1968), St. Lawrence R. watershed.

352. Silver L., Hawkeye Village, Black Brook Twp., Clinton Co., Redford T.M. 7.5' (1968), St. Lawrence R. watershed.

353. Union Falls Pd., Union Falls Village, Black Brook Twp., Clinton Co., Alder Brook T.M. 7.5' (1968), St. Lawrence R. watershed.

354. Cranberry L., Cranberry Lake Village, Clifton Twp., St. Lawrence Co., Cranberry Lake T.M. 7.5' (1968), St. Lawrence R. watershed.

355. Dillon Pd., 3 km W of Cranberry Lake Village on Tooley Pond Rd., State Fishing Access Site, Clifton Twp., St. Lawrence Co., Cranberry Lake T.M. 7.5' (1968), St. Lawrence R. watershed.

356. Childwold Pd., Rte. 3, 1.5 km E of junction with Rte. 56, Colton Twp., St. Lawrence Co., Childwold T.M. 7.5' (1968), St. Lawrence R. watershed.

357. Catamount Pd., N shore, Piercefield Twp., St. Lawrence Co., Childwold T.M. 7.5' (1968), St. Lawrence R. watershed.

358. Tupper L., Simon Pd. marshes, Rte. 30, Moody Village, Altamount Twp., Franklin Co., Long Lake T.M. 15.0' (1955), St. Lawrence R. watershed.

359. Limekiln L., NE shore, Inlet Twp., Hamilton Co., Old Forge T.M. 15.0' (1954), St. Lawrence R. watershed.

360. Fourth L., Fulton Chain, E shore, Inlet Twp., Hamilton Co., Big Moose T.M. 15.0' (1954), St. Lawrence R. watershed.

361. Eagle Cr., Big Moose Rd., Eagle Bay Village, Webb Twp., Herkimer Co., Big Moose T.M. 15.0' (1954), St. Lawrence R. watershed.

362. Big Moose L., SE shore, public boat launch, Webb Twp., Herkimer Co., Big Moose T.M. 15.0' (1954), St. Lawrence R. watershed.

363. Moss L., NW shore, Webb Twp., Herkimer Co., Big Moose T.M. 15.0' (1954), St. Lawrence R. watershed.

364. Bald Mountain Pd., Rte. 28, 5 km E of Old Forge Village, Webb Twp., Herkimer Co., Old Forge T.M. 15.0' (1954), St. Lawrence R. watershed.

365. Nicks L., 3 km S of Old Forge Village, Webb Twp., Herkimer Co., Old Forge T.M. 15.0′ (1954), St. Lawrence R. watershed.

366. Black R., Rte. 28, above spillway, Hawkinsville Village, Boonville Twp., Oneida Co., Boonville T.M. 7.5′ (1955), St. Lawrence R. watershed.

367. Black R. Canal, Rte. 46, 1.5 km S of Jackson Hill Rd., Boonville Twp., Oneida Co., Boonville T.M. 7.5′ (1955), Hudson R. watershed.

368. Lansing Kill, above Pixley Falls, Boonville Gorge State Park, Hurlbutville Village, Boonville Twp., Oneida Co., Boonville T.M. 7.5′ (1955), Hudson R. watershed.

369. Lansing Kill, gaging station, Hillside Village, Western Twp., Oneida Co., Westernville T.M. 7.5′ (1955), Hudson R. watershed.

370. Mohawk R., Webster Hill Rd., Hillside Village, Western Twp., Oneida Co., Westernville T.M. 7.5′ (1955), Hudson R. watershed.

371. Hennesey Road Pd., S side of Hennesey Rd., 0.4 km W of Potato Hill Rd., Boonville Twp., Oneida Co., Boonville T.M. 7.5′ (1955), St. Lawrence R. watershed.

372. Sugar R., Denley Rd., 1.3 km E of Talcottville Village, Leyden Twp., Oneida Co., Port Leyden T.M. 7.5′ (1966), St. Lawrence R. watershed.

373. Cold Bk., Marmon Rd., 0.1 km N of East Main St., Lyonsdale Twp., Lewis Co., Port Leyden T.M. 7.5′ (1966), St. Lawrence R. watershed.

374. Black R., Community Memorial Park, W of Lyons Falls Village, Lyonsdale Twp., Lewis Co., Port Leyden T.M. 7.5′ (1966), St. Lawrence R. watershed.

375. Whetstone Cr., Whetstone Gulf State Park, Martinsburg, Lewis Co., Glenfield T.M. 7.5′ (1966), St. Lawrence R. watershed.

376. Ditch, E side of East Rd., 0.2 km from Rte. 12D, Turin Twp., Lewis Co., Glenfield T.M. 7.5′ (1966), St. Lawrence R. watershed.

377. Kayuta L., Dustin Rd. Causeway, Forestport Twp., Oneida Co., Forestport T.M. 7.5′ (1945), St. Lawrence R. watershed.

378. Cincinnati Cr., 0.3 km S of Rte. B28, Remsen Village, Trenton Twp., Oneida Co., Remsen T.M. 7.5′ (1955), Hudson R. watershed.

379. West Canada Cr., strand pools, below bridge E of Trenton Falls Village, Russia Twp., Herkimer Co., Remsen T.M. 7.5′ (1955), Hudson R. watershed.

380. Feeder Canal from West Canada Cr., Trenton Falls Village, Trenton Twp., Oneida Co., Remsen T.M. 7.5′ (1955), Hudson R. watershed.

381. Hinckley Reservoir, impoundment of West Canada Cr., SE shore N of West Canada Cr. inlet, Hinckley Reservoir State Park, Russia Twp., Herkimer Co., Hinckley T.M. 7.5′ (1946), Hudson R. watershed.

382. *Typha* marsh, entrance gate of Hinckley Reservoir State Park, Russia Twp., Herkimer Co., Hinckley T.M. 7.5′ (1946), Hudson R. watershed.

383. Pond, unnamed, 0.6 km N of Grant Village, Russia Twp., Herkimer Co., Hinckley T.M. 7.5′ (1946), Hudson R. watershed.

384. Piseco L., Irondequoit Bay, Arietta Twp., Hamilton Co., Piseco Lake T.M. 15.0′ (1954), Hudson R. watershed.

385. L. Alma, impoundment of Kennels Pd. outlet, Rte. 10, 1.0 km NW of Averys Place, Arietta Twp., Hamilton Co., Piseco Lake T.M. 15.0′ (1954), Hudson R. watershed.

386. West L. Inlet, Rte. 10, 0.6 km NW of Mud L., West Lake State Boat Launch, Caroga Lake Twp., Fulton Co., Canada Lake T.M. 7.5′ (1945), Hudson R. watershed.

387. Great Sacandaga L., SW shore, Rte. 30, W of Paradise Point, marshy area next to inlet stream, Mayfield Twp., Fulton Co., Northville T.M. 7.5′ (1970), Hudson R. watershed.

388. Susquehanna R., S bank, Rte. 17 rest stop, 0.7 km SW of Squaw Island, Nichols Twp., Tioga Co., Owego T.M. 7.5′ (1969), Susquehanna R. watershed.

389. Wappasening Cr., Kirby Park, Nichols Village, Nichols Twp., Tioga Co., Owego T.M. 7.5′ (1969), Susquehanna R. watershed.

390. Catharine Cr., Rte. 14 & road to Chemung College, 1 km S of Hoffsomer Rd., 1.4 km S of Pine Valley Village, Veteran Twp., Chemung Co., Horseheads T.M. 7.5′ (1969), St. Lawrence R. watershed.

391. Newton Cr., bridge at Bowman Hill Rd., 0.2 km S of Rte. 223, Horseheads Twp., Chemung Co., Horseheads T.M. 7.5′ (1969), Susquehanna R. watershed.

392. Johnson Hollow Stream, unnamed pond, 3 km NW of Rte. 14, Catlin Twp., Chemung Co., Montour Falls T.M. 7.5′ (1978), St. Lawrence R. watershed.

393. Sleeper Cr., Rte. 14 bridge, Veteran Twp., Chemung Co., Montour Falls T.M. 7.5′ (1978), St. Lawrence R. watershed.

394. Diversion Channel, from Catharine Cr. to Barge Canal, 0.1 km S of Rte. 224, Montour Falls Twp., Schuyler Co., Montour Falls T.M. 7.5′ (1978), St. Lawrence R. watershed.

395. Barge Canal, Marina Rd., 1.2 km NE of Rte. 14, Montour Falls Twp., Schuyler Co., Montour Falls T.M. 7.5′ (1978), St. Lawrence R. watershed.

396. Bad Indian Swamp, across Rte. 14 from Aunt Sarah's Falls, Montour Falls Twp.. Schuyler Co., Montour Falls T.M. 7.5' (1978), St. Lawrence R. watershed.

397. Aunt Sarah's Falls & Pool, Rte. 14, Montour Falls Twp., Schuyler Co., Montour Falls T.M. 7.5' (1978), St. Lawrence R. watershed.

398. Seneca L., S shore, Lakeside Park, Watkins Glen Village, Dix Twp., Schuyler Co., Burdett T.M. 7.5' (1950), St. Lawrence R. watershed.

399. Tobehanna Cr., unnamed tributary, Altay Rd., 0.1 km E of Rte. 226, Altay Village, Tyrone Twp., Schuyler Co., Wayne T.M. 7.5' (1953), Susquehanna R. watershed.

400. Lamoka & Waneta Lakes, unnamed connecting stream, 1.3 km W of Weston Village, Department of Environmental Conservation Waneta-Lamoka Fishing Access Site, Tyrone Twp., Schuyler Co., Wayne T.M. 7.5' (1953), Susquehanna R. watershed.

401. Keuka L., inlet, Rte. 54, Chaplin Beach, 1 km E of Rte. 54A, Hammondsport Village, Urbana Twp., Steuben Co., Hammondsport T.M. 7.5' (1953), St. Lawrence R. watershed.

402. Keuka L., SW shore, Liberty St., Hammondsport Village, Urbana Twp., Steuben Co., Hammondsport T.M. 7.5' (1953), St. Lawrence R. watershed.

403. Pond, unnamed, Gaging Station Rd. & Rte. 63, 3 km S of Geneseo Village, Geneseo Twp., Livingston Co., Geneseo T.M. 7.5' (1978), St. Lawrence R. watershed.

404. Genesee R., Jones Bridge Rd., Leicester Twp., Livingston Co., Geneseo T.M. 7.5' (1978), St. Lawrence R. watershed.

405. Beards Cr., Rte. 39, Boyd-Parker State Park, Leicester Twp., Livingston Co., Geneseo T.M. 7.5' (1978), St. Lawrence R. watershed.

406. Beards Cr., unnamed tributary, River Rd., 0.2 km S of Jones Bridge Rd., 1.5 km S of Cuylerville Village, Leicester Twp., Livingston Co., Geneseo T.M. 7.5' (1978), St. Lawrence R. watershed.

407. Silver L. Outlet, old railroad bridge, 0.5 km W of Rte. 39, Perry Village, Perry Twp., Wyoming Co., Castile T.M. 7.5' (1972), St. Lawrence R. watershed.

408. Silver L. Outlet, Silver Lake Rd. boat launch, Perry Twp., Wyoming Co., Castile T.M. 7.5' (1972), St. Lawrence R. watershed.

409. Silver Lake, unnamed tributary impoundment, East Lake Rd., Silver Lake State Park, Castile Twp., Wyoming Co., Castile T.M. 7.5' (1972), St. Lawrence R. watershed.

410. Ditch, unnamed, East Lake Rd., Silver Lake State Park, Castile Twp., Wyoming Co., Castile T.M. 7.5' (1972), St. Lawrence R. watershed.

411. Pond, unnamed seepage, Letchworth State Park, 1.5 km S of Castile entrance, Genesee Falls Twp., Wyoming Co., Portageville T.M. 7.5' (1972), St. Lawrence R. watershed.

412. Trout Pd., Letchworth State Park, falls section, Genesee Falls Twp., Wyoming Co., Portageville T.M. 7.5' (1972), St. Lawrence R. watershed.

413. Moss L., Sand Hill Rd., Caneadea Twp., Allegany Co., Houghton T.M. 7.5' (1964), St. Lawrence R. watershed.

414. Rushford L., W shore, picnic area W of Caneadea Dam, Caneadea Twp., Allegany Co., Houghton T.M. 7.5' (1964), St. Lawrence R. watershed.

415. Genesee Valley Canal, South Rd., 1 km S of Rte. 305, Cuba Twp., Allegany Co., Black Creek T.M. 7.5' (1964), Mississippi R. watershed.

416. Allegheny R., N shore, bridge 0.6 km SE of North Ninemile Rd., Vandalia Village, Allegany Twp., Cattaraugus Co., Knapp Creek T.M. 7.5' (1979), Mississippi R. watershed.

417. Tonungwant Cr., Irvine Mills Rd. bridge, Allegany State Park, Irvine Mills Village, Carrollton Twp., Cattaraugus Co., Limestone T.M. 7.5' (1961), Mississippi R. watershed.

418. Limestone Bk., Limestone Run Rd., 2 km W of South Carrollton Rd., Allegany State Park, Carrollton Twp., Cattaraugus Co., Limestone T.M. 7.5' (1961), Mississippi R. watershed.

419. Red House Bk., France Brook Rd., Allegany State Park, Red House Twp., Cattaraugus Co., Limestone T.M. 7.5' (1961), Mississippi R. watershed.

420. Red House L., NE shore, Allegany State Park, Red House Twp., Cattaraugus Co., Limestone T.M. 7.5' (1961), Mississippi R. watershed.

421. Quaker Run & S shore of Quaker L., at Cain Hollow, Allegany State Park, Elko Twp., Cattaraugus Co., Red House T.M. 7.5' (1980), Mississippi R. watershed.

422. Stillson Pd. Inlet, Rte. 394, 1.2 km SE of East Randolph Village, Cold Spring Twp., Cattaraugus Co., Randolph T.M. 7.5' (1979), Mississippi R. watershed.

423. Randolph High School Pd. No. 1, Rte. 394, Randolph High School, 0.5 km E of Rte. 241, Randolph Twp., Cattaraugus Co., Randolph T.M. 7.5' (1979), Mississippi R. watershed.

424. Randolph High School Pd. No. 2, Rte. 394, Randolph High School, 0.3 km E of Rte. 241, Randolph Twp., Cattaruagus Co., Randolph T.M. 7.5' (1979), Mississipi R. watershed.

425. Little Conewango Cr., Rte. 394, Randolph Village, Randolph Twp., Cattaraugus Co., Randolph T.M. 7.5' (1979), Mississippi R. watershed.

426. Ditch, roadside, Jones-Gifford Ave. & Walden Ave., NW corner of Jamestown City, Ellicott Twp., Chautauqua Co., Lakewood T.M. 7.5′ (1954), Mississippi R. watershed.

427A. Chautauqua L., Sherman's Bay, Rte. 17J, 0.4 km NW of Rte. 74, Busti Twp., Chautauqua Co., Lakewood T.M. 7.5′ (1954), Mississippi R. watershed.

427B. Chautauqua L., Long Point, boat launch, Chautauqua Lake State Park, Ellery Twp., Chautauqua Co., Chautauqua T.M. 7.5′ (1954), Mississippi R. watershed.

428. Goose Cr., Rte. 394 (17J), 0.7 km S of Loomises Village, Busti Twp., Chautauqua Co., Lakewood T.M. 7.5′ (1954), Mississippi R. watershed.

429. French Cr. unnamed tributary, S of East Main St. (Rte. 430) & Warden, Sherman Village, Sherman Twp., Chautauqua Co., Sherman T.M. 7.5′ (1954), Mississippi R. watershed.

430A. Findley L., N shore, State Boat Launch, Rte. 430 & 426, Mina Twp., Chautauqua Co., Clymer T.M. 7.5′ (1954), Mississippi R. watershed.

430B. Findley L., S shore at Shady Rd., Mina Twp., Chautauqua Co., Clymer T.M. 7.5′ (1954), Mississippi R. watershed.

431. French Cr., Rte. 430, below Findley Lake Dam, Mina Twp., Chautauqua Co., Clymer T.M. 7.5′ (1954), Mississippi R. watershed.

432. Findley L. Inlet, unnamed pond, S of Shady Side Rd., 0.5 km W of Rte. 426, Mina Twp., Chautauqua Co., Clymer T.M. 7.5′ (1954), Mississippi R. watershed.

433. Chautauqua Cr., Rte. 5 bridge, Barcelona Village, Westfield Twp., Chautauqua Co., Westfield T.M. 7.5′ (1954), St. Lawrence R. watershed.

436. Fishing Pd., Joseph Davis State Park, Rte. 18F, Lewiston Twp., Niagara Co., Lewiston T.M. 7.5′ (1980), St. Lawrence R. watershed.

437. Niagara R., Joseph Davis State Park fishing dock, Rte. 18F, Lewiston, Niagara Co., Lewiston T.M. 7.5′ (1980), St. Lawrence R. watershed.

438. Niagara R., Fort Niagara State Park boat launch, Porter Twp., Niagara Co., Fort Niagara T.M. 7.5′ (1980), St. Lawrence R. watershed.

439. Sixmile Cr. Marsh, Rte. 18, Porter Twp., Niagara Co., Sixmile Creek T.M. 7.5′ (1965), St. Lawrence R. watershed.

440. Twelvemile Cr., east branch, Rte. 18, Wilson Twp., Niagara Co., Wilson T.M. 7.5′ (1965), St. Lawrence R. watershed.

441. Eighteenmile Cr., Olcott Village, Town of Newfane Boat Launch, Newfane Twp., Niagara Co., Newfane T.M. 7.5′ (1978), St. Lawrence R. watershed.

442. Johnson Cr., Rte. 63, below dam, Lyndonville Village, Yates Twp., Orleans Co., Lyndonville T.M. 7.5′ (1979), St. Lawrence R. watershed.

443. Erie Canal, boat launch at N side of Bates Rd. bridge, Medina Village, Ridgeway Twp., Orleans Co., Knowlesville T.M. 7.5′ (1950), St. Lawrence R. watershed.

444. Pond, unnamed, S of Otter Cr. at Erie Canal, Presbyterian Rd., 2 km E of Knowlesville Village, Albion Twp., Orleans Co., Knowlesville T.M. 7.5′ (1950), St. Lawrence R. watershed.

445A. L. Ontario, Irondequoit Bay, Empire Boulevard (Rte. 404), 1.2 km E of Rte. 590 (Rte. 47), Irondequoit Twp., Monroe Co., Rochester East T.M. 7.5′ (1971), St. Lawrence R. watershed.

445B. L. Ontario, Irondequoit Bay, Empire Boulevard (Rte. 404), boat launch 1.9 km E of Rte. 590 (Rte. 47), Penfield Twp., Monroe Co., Rochester East T.M. 7.5′ (1971), St. Lawrence R. watershed.

445C. L. Ontario, Irondequoit Bay, boat launch at Bay Front St. & Orchard Park Boulevard, Irondequoit Bay Park, Irondequoit Twp., Monroe Co., Rochester East T.M. 7.5′ (1971), St. Lawrence R. watershed.

448A. Oneida L., Muskrat Bay, Oneida Shores County Park, Cicero Twp., Onondaga Co., Cicero T.M. 7.5′ (1973), St. Lawrence R. watershed.

448B. Oneida L., S shore, Eagle Bay, Shackleton Point State Boat Launch, Sullivan Twp., Madison Co., Cleveland T.M. 7.5′ (1957), St. Lawrence R. watershed.

449. Chittenango Cr., Anchorage Marina, Hitchcock Rd., 3.5 km NW of Bridgeport Village, Sullivan Twp., Madison Co., Cleveland T.M. 7.5′ (1957), St. Lawrence R. watershed.

450. Ditch, Oneida Shores County Park, Cicero Twp., Onondaga Co., Cicero T.M. 7.5′ (1973), St. Lawrence R. watershed.

451. Stream, unnamed, & vernal pond, Orange Camp Rd., 0.9 km SE of Scotchtown Rd., Highland Lakes State Park, Wallkill Twp., Orange Co., Goshen T.M. 7.5′ (1957), Hudson R. watershed.

452. Pond, unnamed, S side of Pufftown Rd., 0.7 km E of Scotchtown Rd., Highland Lakes State Park, Wallkill Twp., Orange Co., Goshen T.M. 7.5′ (1957), Hudson R. watershed.

453. Masonic Cr., Bert Crawford Rd., Middletown, Wallkill Twp., Orange Co., Middletown T.M. 7.5′ (1969), Hudson R. watershed.

454. Neversink R., Rte. 209, Meyers Road Village, Deerpark Twp., Orange Co., Otisville T.M. 7.5′ (1976), Delaware R. watershed.

455. Delaware-Hudson Canal, Delaware-Hudson Canal Park, Hoag Rd., S of Cuddebackville, Deerpark Twp., Orange Co., Otisville T.M. 7.5' (1976), Delaware R. watershed.

456. Neversink R., at Delaware-Hudson Canal, S of Cuddeville, Deerpark Twp., Orange Co., Otisville T.M. 7.5' (1976), Delaware R. watershed.

457. Martin L. & Gold Cr. (outlet), Cejwin Camp, Rte. 209, 3 km S of Huguenot, Deerpark Twp., Orange Co., Port Jervis North T.M. 7.5' (1942), Delaware R. watershed.

458. Delaware R., West Main St., 1.5 km NW of Germantown, Deerpark Twp., Orange Co., Port Jervis North T.M. 7.5' (1942), Delaware R. watershed.

459. Pond, unnamed, N side of Thornton Rd, 0.2 km E of Rte. 209, Phillipsport, Mamakating Twp., Sullivan Co., Ellenville T.M. 7.5' (1969), Hudson R. watershed.

460. Delaware-Hudson Canal, Thornton Rd., 1.6 km SW of Phillipsport, Mamakating Twp., Sullivan Co., Ellenville T.M. 7.5' (1969), Hudson R. watershed.

461. Homowack Kill, 0.5 km SW of Phillipsport Village, Rte. 209, Mamakating Twp., Sullivan Co., Ellenville T.M. 7.5' (1969), Hudson R. watershed.

462. Delaware-Hudson Canal, Rte. 209, Summitville, Mamakating Twp., Sullivan Co., Wurtsboro T.M. 7.5' (1969), Delaware R. watershed.

463. Delaware-Hudson Canal, McDonald Rd., 3 km N of Wurtsboro Village, Mamakating Twp., Sullivan Co., Wurtsboro T.M. 7.5' (1969), Delaware R. watershed.

464. Pond, unnamed, road paralleling N to Rte. 17, 1 km S of Wanaksink L., Thompson Twp., Sullivan Co., Yankee Lake T.M. 7.5' (1966), Delaware R. watershed.

465. White L., W shore, State Boat Launch, Rte. 55 & Lake Drive, Kauneoga Lake Village, Bethel Twp., Sullivan Co., White Lake T.M. 7.5' (1967), Delaware R. watershed.

466. L. Superior, at outlet, Duggan Rd., Lake Superior State Park, Bethel Twp., Sullivan Co., White Lake T.M. 7.5' (1967), Delaware R. watershed.

467. Black Lake Cr., Moscoe Rd., at Toronto Reservoir, 1.3 km SE of Black Lake Village, Bethel Twp., Sullivan Co., White Lake T.M. 7.5' (1967), Delaware R. watershed.

468. Swan L., S shore, causeway, 2 km NW of Swan Lake Village, Liberty Twp., Sullivan Co., Liberty West T.M. 7.5' (1965), Delaware R. watershed.

469. Beaver Kill, unnamed tributary ditch, Old Rte. 17 at Tweedie Rd., E of Ben Gray Hollow, Hancock Twp., Delaware Co., Horton T.M. 7.5' (1982), Delaware R. watershed.

470. Delaware R., East Branch backwater, Earlys Flat, Roadside Park, 2.5 km W of East Branch Village, Hancock Twp., Delaware Co., Fishs Eddy T.M. 7.5' (1965), Delaware R. watershed.

471. Delaware R., East Branch, Fishs Eddy Village, at bridge, Hancock Twp., Delaware Co., Fishs Eddy T.M. 7.5' (1965), Delaware R. watershed.

472. Outlet of unnamed pond, West Main St. & Front St., Hancock Village, Hancock Twp., Delaware Co., Hancock T.M. 7.5' (1965), Delaware R. watershed.

473. Whitaker Brook Pd., McCabe Hollow Rd., Deposit Twp., Delaware Co., Deposit T.M. 7.5' (1965), Delaware R. watershed.

474. Pond, unnamed, Columbia Lake Rd., NE of Laurel Hill Cemetery, Deposit Twp., Delaware Co., Deposit T.M. 7.5' (1965), Delaware R. watershed.

475. Deer L. at Fly Cr. (outlet), Old Rte. 17, Sanford-Windsor Township line, Broome Co., Gulf Summit T.M. 7.5' (1952), Delaware R. watershed.

476. Tuscarora Cr., Old Rte. 17, Windsor-Sanford Township line, Broome Co., Gulf Summit T.M. 7.5' (1952), Susquehanna R. watershed.

477. Belden Bk., unnamed tributary, Rte 79 & Hickox Rd., Colesville Twp., Broome Co., Belden T.M. 7.5' (1957), Susquehanna R. watershed.

478. Marsh, unnamed, Rte. 79, 1.6 km SE of North Colesville Village, Colesville Twp., Broome Co., Belden T.M. 7.5' (1957), Susquehanna R. watershed.

493. Onondaga L., NE shore, 0.2 km SE of Salt Museum, Liverpool Twp., Onondaga Co., Syracuse West T.M. 7.5' (1978), St. Lawrence R. watershed.

494. Pond, unnamed, Onondaga Lake Park, 2 km SE of lake outlet, Liverpool Twp., Onondaga Co., Syracuse West T.M. 7.5' (1978), St. Lawrence R. watershed.

495. Oswego R., S of Battle Island, Battle Island State Park, Granby Twp., Oswego Co., Fulton T.M. 7.5' (1978), St. Lawrence R. watershed.

496. Pond, unnamed, 1.3 km S of Minetto Village, Rte. 48, Minetto Twp., Oswego Co., Oswego East T.M. 7.5' (1978), St. Lawrence R. watershed.

497. Sterling Valley Cr., 0.7 km WNW of McKnight Corners, McIntyre Rd., Sterling Twp., Cayuga Co., Fair Haven T.M. 7.5' (1976), St. Lawrence R. watershed.

498. The Pond, W shore, Fair Haven State Park, Sterling Twp., Cayuga Co., Fair Haven T.M. 7.5' (1976), St. Lawrence R. watershed.

499. L. Ontario, Little Sodus Bay, SW shore public boat launch, West Bay Rd., Sterling Twp., Cayuga Co., Fair Haven T.M. 7.5' (1976), St. Lawrence R. watershed.

500. Red Cr., Broadway Rd. bridge, Wolcott Twp., Wayne Co., North Wolcott T.M. 7.5' (1953), St. Lawrence R. watershed.

501. Wolcott Cr., Rte. 104, Wolcott Falls Park, below falls, Wolcott Twp., Wayne Co., Wolcott T.M. 7.5' (1953), St. Lawrence R. watershed.

502A. L. Ontario, Sodus Bay, Ridge Rd., Resort Village, Huron Twp., Wayne Co., Rose T.M. 7.5′ (1978), St. Lawrence R. watershed.

502B. L. Ontario, Sodus Bay, Sawmill Cove, Red Mill Rd., Huron Twp., Wayne Co., Rose T.M. 7.5′ (1978), St. Lawrence R. watershed.

503. Canandaigua Outlet, Rte. 31 bridge, Lyons Village, Lyons Twp., Wayne Co., Lyons T.M. 7.5′ (1953), St. Lawrence R. watershed.

504. The Wide Waters, Erie Canal, Rte. 31, Wide Waters Park, Arcadia Twp., Wayne Co., Palmyra T.M. 7.5′ (1952), St. Lawrence R. watershed.

505. Conesus L., East Lake Rd., State boat launch, 0.5 km S of Hartson Pt., Livonia Twp., Livingston Co., Livonia T.M. 7.5′ (1951), St. Lawrence R. watershed.

506. North McMillan Cr., East Lake Rd. bridge, Conesus Twp., Livingston Co., Conesus T.M. 7.5′ (1942), St. Lawrence River watershed.

507. Conesus Lake Inlet, Sliker Hill Rd., Conesus Twp., Livingston Co., Conesus T.M. 7.5′ (1942), St. Lawrence R. watershed.

508. *Typha* ditch, N side of Sliker Hill Rd., E of Conesus Inlet, Conesus Twp., Livingston Co., Conesus T.M. 7.5′ (1942), St. Lawrence R. watershed.

509. Ditch, unnamed, Rte. 15, 1.2 km N of Liberty Rd., Springwater Twp., Livingston Co., Springwater T.M. 7.5′ (1942), St. Lawrence R. watershed.

510. Pond, unnamed, E of Rte. 15, 1.1 km N of Liberty Rd., Springwater Twp., Livingston Co., Springwater T.M. 7.5′ (1942), St. Lawrence R. watershed.

511. Hemlock L., N shore, Hemlock Lake Park, Glenville Village, Livonia Twp., Livingston Co., Honeoye T.M. 7.5′ (1951), St. Lawrence R. watershed.

512. Hemlock L. Outlet, Rix Hill Rd., Hemlock Lake Park, Glenville Village, Livonia Twp., Livingston Co., Honeoye T.M. 7.5′ (1951), St. Lawrence R. watershed.

513. Canadice L. Outlet, N end of Canadice L., Canadice, Ontario Co., Springwater T.M. 7.5′ (1942), St. Lawrence R. watershed.

514. Keuka L., E shore, Rte. 54, 9 km S of Penn Yan, Sunset Point, Milo Twp., Steuben Co., Keuka Park T.M. 7.5′ (1942), St. Lawrence R. watershed.

515. Keuka L., N shore, Seneca Point, Red Jacket Park, Milo Twp., Steuben Co., Penn Yan T.M. 7.5′ (1942), St. Lawrence R. watershed.

516. Nettle Valley Cr., Rte. 364, Potter Twp., Yates Co., Potter T.M. 7.5′ (1942), St. Lawrence R. watershed.

517. Flint Cr., Rte. 364, Potter Park, Potter Village, Potter Twp., Yates Co., Potter T.M. 7.5′ (1942), St. Lawrence R. watershed.

518A. Canandaigua L., E shore, Rte. 364, 0.1 km N of County Rd. 1, Deep Run Park, Cottage City Village, Gorham Twp., Ontario Co., Canandaigua Lake T.M. 7.5′ (1951), St. Lawrence R. watershed.

518B. Canandaigua L., N shore, Rte. 20, Kershaw Park, Canandaigua Twp., Ontario Co., Canandaigua Lake T.M. 7.5′ (1951), St. Lawrence R. watershed.

519. Deep Run, Rte. 364, Cottage City Village, Gorham Twp., Ontario Co., Canandaigua T.M. 7.5′ (1951), St. Lawrence R. watershed.

520. Canandaigua Outlet backwater pond, 0.4 km N of Rte. 20, 0.7 km E of Feeder Canal, City of Canandaigua, Canandaigua Twp., Ontario Co., Canandaigua T.M. 7.5′ (1951), St. Lawrence R. watershed.

521. Canandaigua Outlet Control Pd., N of Rte. 5 & 20 at dam, 0.3 km NW of Rte. 364, Canandaigua Twp., Ontario Co., Canandaigua Lake T.M. 7.5′ (1951), St. Lawrence R. watershed.

522. Ditch, unnamed, E side of Kearney Rd. at Rte. 5 & 20, Aloquin Village, Hopewell Twp., Ontario Co., Rushville T.M. 7.5′ (1978), St. Lawrence R. watershed.

523. Pond, unnamed, S side of Rte. 5 & 20, between County Rd. 17 & Spangle Rd., Hopewell Twp., Ontario Co., Rushville T.M. 7.5′ (1978), St. Lawrence R. watershed.

524A. Seneca L., N shore, Geneva Twp., Seneca Co., Geneva South T.M. 7.5′ (1978), St. Lawrence R. watershed.

524B. Seneca L., N shore at Point, Geneva Twp., Seneca Co., Geneva South T.M. 7.5′ (1978), St. Lawrence R. watershed.

525. Ditch, west, into Seneca L., Seneca Lake State Park, Waterloo Twp., Ontario Co., Geneva South T.M. 7.5′ (1978), St. Lawrence R. watershed.

526. Ditch, east, into Seneca L., Seneca Lake State Park, Waterloo Twp., Ontario Co., Geneva South T.M. 7.5′ (1978), St. Lawrence R. watershed.

527. Cayuga & Seneca Canal, Seneca Lake State Park piers, Waterloo Twp., Seneca Co., Geneva South T.M. 7.5′ (1978), St. Lawrence R. watershed.

528. Hoopes Park Pd., East Genesee St. (Rte. 20), City of Auburn, Sennett Twp., Cayuga Co., Auburn T.M. 7.5′ (1954), St. Lawrence R. watershed.

529. Owasco L. Outlet, Rte. 38A, Emerson Park, Owasco Twp., Cayuga Co., Auburn T.M. 7.5′ (1954), St. Lawrence R. watershed.

530. Owasco L., N shore, Rte. 38A, Emerson Park, Owasco Twp., Cayuga Co., Auburn T.M. 7.5′ (1954), St. Lawrence R. watershed.

531. Cayuga & Seneca Canal, Mud Lock Rd., Mud Lock State Boat Launch, Aurelius Twp., Cayuga Co., Cayuga T.M. 7.5′ (1954), St. Lawrence R. watershed.

532. Canal, abandoned, Mud Lock Rd., 0.1 km S of Mudlock Canal, Aurelius Twp., Cayuga Co., Cayuga T.M. 7.5′ (1954), St. Lawrence R. watershed.

533. Montezuma Marsh main pool, E shore, Montezuma National Wildlife Refuge, Tyre Twp., Seneca Co., Cayuga T.M. 7.5′ (1954), St. Lawrence R. watershed.

534. Cayuga & Seneca Canal, State Boat Launch, 0.1 km S of Rte. 5 & 20, Montezuma National Wildlife Refuge, Tyre Twp., Seneca Co., Cayuga T.M. 7.5′ (1954), St. Lawrence R. watershed.

535. Cayuga L., W shore, Rte. 89, Cayuga Lake State Park, Seneca Falls Twp., Seneca Co., Seneca Falls T.M. 7.5′ (1953), St. Lawrence R. watershed.

536. Ditch, unnamed, S of and paralleling Cohocton R., 0.2 km E of Rte. 15, Erwin Twp., Steuben Co., Corning T.M. 7.5′ (1969), Susquehanna R. watershed.

537. Tioga R., unnamed tributary, Rte. 17 culvert, Erwin Twp., Steuben Co., Corning T.M. 7.5′ (1969), Susquehanna R. watershed.

538. Cohocton R., 0.3 km E of Canada Rd., 1.1 km NW of Rte. 17/15, Erwin, Steuben Co., Corning T.M. 7.5′ (1969), Susquehanna R. watershed.

539. Meads Cr., Meads Creek Rd. bridge, 0.6 km N of Rte. 17, Campbell Twp., Steuben Co., Campbell T.M. 7.5′ (1978), Susquehanna R. watershed.

540. Van Keuren L., E shore, Round Lake Rd., Bath Twp., Steuben Co., Savona T.M. 7.5′ (1953), Susquehanna R. watershed.

541. Van Keuren L. Inlet, Round Lake Rd., Bath Twp., Steuben Co., Savona T.M. 7.5′ (1953), Susquehanna R. watershed.

542. Sanford L., SW shore, Sanford Lake State Recreation Area, Bath Twp., Steuben Co., Savona T.M. 7.5′ (1953), Susquehanna R. watershed.

543. Salubria L., S shore, Rte. 415, Bath Twp., Steuben Co., Bath T.M. 7.5′ (1978), Susquehanna R. watershed.

544. Fivemile Cr., gaging station, Hemlock Rd., Wheeler Twp., Steuben Co., Rheims T.M. 7.5′ (1978), Susquehanna R. watershed.

545. Mud L., E shore, 0.9 km E of Rte. 53, Beans Station, Prattsburg Twp., Steuben Co., Rheims T.M. 7.5′ (1978), Susquehanna R. watershed.

546. Goff Cr., 2 km E of Palmer Rd., 0.8 km S of Starr Rd., Howard Twp., Steuben Co., Canisteo T.M. 7.5′ (1978), Susquehanna R. watershed.

547. Canacadea Cr., Main St. (Rte. 21), 2 km W of Rte. 36, at gaging station, Hornellsville Twp., Steuben Co., Hornell T.M. 7.5′ (1978), Susquehanna R. watershed.

548. Ditch, Rte. 36, E side, 0.9 km S of Gravel Run, Canisteo Twp., Steuben Co., South Canisteo T.M. 7.5′ (1954), Susquehanna R. watershed.

549. Fuller Hollow Cr., Murray Hill Rd. & Rte. 434, Vestal Twp., Broome Co., Binghamton West T.M. 7.5′ (1968), Susquehanna R. watershed.

550. Glen Castle Cr., Rte. 12 bridge, Chenango Twp., Broome Co., Castle Creek T.M. 7.5′ (1976), Susquehanna R. watershed.

551. Thomas Cr., Rte. 12A bridge, Chenango Bridge Village, Chenango Twp., Broome Co., Castle Creek T.M. 7.5′ (1976), Susquehanna R. watershed.

552. Chenango L. Outlet, Chenango Valley State Park, Fenton Twp., Broome Co., Chenango Forks T.M. 7.5′ (1968), Susquehanna R. watershed.

553. Chenango L., S shore, Chenango Valley State Park, Fenton Twp., Broome Co., Chenango Forks T.M. 7.5′ (1968), Susquehanna R. watershed.

554. Chenango Canal, S end of Chenango Valley State Park, Fenton Twp., Broome Co., Chenango Forks T.M. 7.5′ (1968), Susquehanna R. watershed.

555. Otselic Cr., unnamed marshy tributary, Landers Corner Rd., 0.3 km W of Rte. 26, Willet Twp., Cortland Co., Willet T.M. 7.5′ (1949), Susquehanna R. watershed.

556. Otselic R., Landers Corners Rd., Landers Corners fishing access site, Willet Twp., Cortland Co., Willet T.M. 7.5′ (1949), Susquehanna R. watershed.

557. Tioughnioga R., Rte. 11, fishing access site, 2.2 km NNW of Marathon Village, Marathon Twp., Cortland Co., Marathon T.M. 7.5′ (1950), Susquehanna R. watershed.

558. Casterline Pd., Rte. 11, public fishing access site, 1.5 km N of Homer Village, Homer Twp., Cortland Co., Homer T.M. 7.5′ (1955), Susquehanna R. watershed.

559. Grout Bk. (Skaneateles L. Inlet), East Lake Rd., 0.2 km S of Glen Haven Rd., Scott Twp., Cortland Co., Spafford T.M. 7.5′ (1955), St. Lawrence R. watershed.

560. Grout Bk., Glen Haven Rd., Scott Twp., Cortland Co., Spafford T.M. 7.5′ (1955), St. Lawrence R. watershed.

561. Grout Bk., dry strand pool, near mouth of Skaneateles L., Scott Twp., Cortland Co., Spafford T.M. 7.5′ (1955), St. Lawrence R. watershed.

562. Cazenovia L., S shore, Lakeside Park, Cazenovia Village, Cazenovia Twp., Madison Co., Cazenovia T.M. 7.5′ (1943), St. Lawrence R. watershed.

563. Cazenovia L. marsh, Rte. 20, S shore of Cazenovia L., Cazenovia Twp., Madison Co., Cazenovia T.M. 7.5′ (1943), St. Lawrence R. watershed.

564. Chittenango Cr., Rte. 13, fishing access site, 1 km S of Chittenango Falls State Park, Cazenovia Twp., Madison Co., Cazenovia T.M. 7.5′ (1943), St. Lawrence R. watershed.

565. Old Erie Canal, Lakeport Rd. bridge, Old Erie Canal State Park, N edge of Chittenango Village, Sullivan Twp., Madison Co., Canastota T.M. 7.5′ (1957), St. Lawrence R. watershed.

566. Marsh, unnamed, E of Beebe Bridge Rd., S of Old Erie Canal, Old Erie Canal State Park, Lenox Twp., Madison Co., Canastota T.M. 7.5′ (1957), St. Lawrence R. watershed.

567. Tioughnioga R., West Branch, Clinton Avenue bridge, Cortland City, Cortland Twp., Cortland Co., Cortland T.M. 7.5′ (1955), Susquehanna R. watershed.

568. Callico Pd., Callico Pond State Park, Rte. 41, Cincinnatus Twp., Cortland Co., Cincinnatus T.M. 7.5′ (1943), Susquehanna R. watershed.

569. Solon Pd., W shore, Taylor Center, Taylor Twp., Cortland Co., Cincinnatus T.M. 7.5′ (1943), Susquehanna R. watershed.

570. Melody L. (Ellis L.), Melody Lake Rd., Willet Twp., Cortland Co., Willet T.M. 7.5′ (1949), Susquehanna R. watershed.

571. Cincinnatus L., S shore, Willet Twp., Cortland Co., Smithville Flats T.M. 7.5′ (1948), Susquehanna R. watershed.

572. Cincinnatus L., spillway stream, Lakeville Village, Smithville Twp., Chenango Co., Smithville Flats T.M. 7.5′ (1948), Susquehanna R. watershed.

573. Long Pd., NW shore, Rte. 141, State Fishing Access Site, Smithville Twp., Chenango Co., Smithville Flats T.M. 7.5′ (1948), Susquehanna R. watershed.

574. Bowman L., N shore, Bowman Lake State Park, McDonough Twp., Chenango Co., East Pharsalia T.M. 7.5′ (1943), Susquehanna R. watershed.

575. Mead Pd., Rte. 12, North Norwich Twp., Chenango Co., Norwich T.M. 7.5′ (1943), Susquehanna R. watershed.

576. Charlotte Cr., Rte. 23, 1 km W of Prosser Hollow, Davenport Twp., Delaware Co., West Davenport T.M. 7.5′ (1943), Susquehanna R. watershed.

577. Neahwa Park Pd., Neahwa Park, City of Oneonta, Oneonta Twp., Otsego Co., Oneonta T.M. 7.5′ (1943), Susquehanna R. watershed.

578. Susquehanna R., flood plain, Catella Park, City of Oneonta, Oneonta Twp., Otsego Co., Oneonta T.M. 7.5′ (1943), Susquehanna R. watershed.

579. Gilbert L., N shore, Gilbert Lake State Park, New Lisbon Twp., Otsego Co., Morris T.M. 7.5′ (1943), Susquehanna R. watershed.

580. Butternut Cr., impoundment, fairgrounds, Morris Village, Morris Twp., Otsego Co., Morris T.M. 7.5′ (1943), Susquehanna R. watershed.

581. Pond, unnamed, S side of County Rd. 13, 0.5 km S of Deming School, Pittsfield Twp., Otsego Co., New Berlin South T.M. 7.5′ (1943), Susquehanna R. watershed.

582. Silver L., W shore, Silver Lake Village, Pittsfield Twp., Otsego Co., New Berlin South T.M. 7.5′ (1943), Susquehanna R. watershed.

583. Wharton Cr., County Rd. 18 bridge, 1.2 km W of New Berlin Village, Pittsfield Twp., Otsego Co., New Berlin South T.M. 7.5′ (1943), Susquehanna R. watershed.

584. Unadilla R., Adams Rd. bridge, Columbus Twp., Chenango Co., New Berlin North T.M. 7.5′ (1943), Susquehanna R. watershed.

585. Stream, unnamed, Rte. 20, 2.4 km E of Otsego-Herkimer County line, Richfield Twp., Otsego Co., Millers Mills T.M. 7.5′ (1943), Susquehanna R. watershed.

586. Canadarago L., W shore, Rte. 28, public boat launch, Richfield Twp., Otsego Co., Schuyler Lake T.M. 7.5′ (1943), Susquehanna R. watershed.

587. *Typha* ditch, SW side of Rte. 5-S, 2 km NW of Mucky Run Rd., Frankfort Twp., Herkimer Co., Ilion T.M. 7.5′ (1943), Hudson R. watershed.

588. Mohawk R., backwater, 0.3 km NW of Railroad St., Frankfort Village, Frankfort Twp., Herkimer Co., Ilion T.M. 7.5′ (1943), Hudson R. watershed.

589. Fulmer Cr., State Fishing Access Site, Rte. 5-S, Mohawk Village, German Flats Twp., Herkimer Co., Ilion T.M. 7.5′ (1943), Hudson R. watershed.

590. Pond, unnamed, SE corner of Rte. 28 & Allens Lake Rd. intersection, Richfield, Otsego Co., Richfield Springs T.M. 7.5′ (1943), Susquehanna R. watershed.

591. Allen L. Outlet, County Rd. 26, Springfield Twp., Otsego Co., Richfield Springs T.M. 7.5′ (1943), Susquehanna R. watershed.

592. Clarke Pd., E shore, Rte. 80, golf course, Springfield Twp., Otsego Co., Richfield Springs T.M. 7.5′ (1943), Susquehanna R. watershed.

593. Shipman Pd., NW shore, Rte. 80, Springfield Center Village, Springfield Twp., Otsego Co., East Springfield T.M. 7.5' (1943), Susquehanna R. watershed.

594. Beaver pond, unnamed, County Rd. 31, Glimmerglass State Park, Springfield Twp., Otsego Co., East Springfield T.M. 7.5' (1943), Susquehanna R. watershed.

595. Shadow Br., Glimmerglass State Park, Springfield Twp., Otsego Co., East Springfield T.M. 7.5' (1943), Susquehanna R. watershed.

596. Canajoharie Cr., County Rd. & White Rd. bridge, 1.8 km E of Rte. 163, Canajoharie Twp., Montgomery Co., Sprout Brook T.M. 7.5' (1943), Hudson R. watershed.

599. Pond, unnamed, W side of Stringham Rd., 1 km S of Rte. 55, La Grange Twp., Dutchess Co., Pleasant Valley T.M. 7.5' (1957), Hudson R. watershed.

600. Sprout Cr., unnamed tributary, Stringham Rd., Stringham bridge, La Grange Twp., Dutchess Co., Pleasant Valley T.M. 7.5' (1957), Hudson R. watershed.

601. Sprout Cr., Noxon Rd. bridge, La Grange Twp., Dutchess Co., Pleasant Valley T.M. 7.5' (1957), Hudson R. watershed.

602. L. Walton, at NW bay, East Fishkill Twp., Dutchess Co., Hopewell Junction T.M. 7.5' (1981), Hudson R. watershed.

603. Hudson R., E shore, Breakneck Point, Hudson Highlands State Park, Fishkill Twp., Dutchess Co., West Point T.M. 7.5' (1981), Hudson R. watershed.

604. Mohansic L., N shore, Roosevelt (Mohansic) State Park, Yorktown Twp., Westchester Co., Mohegan Lake T.M. 7.5' (1981), Hudson R. watershed.

605. Rockland L., NW shore, Rockland Lake State Park, Clarkstown Twp., Rockland Co., Haverstraw T.M. 7.5' (1979), Hackensack R. watershed.

606. East Bk., North Entrance Rd., Rockland Lake State Park, Clarkstown Twp., Rockland Co., Haverstraw T.M. 7.5' (1979), Hackensack R. watershed.

607. L. Tiorati, E shore, Tiorati Lake Rd., Palisades Interstate Park, Tuxedo Twp., Orange Co., Popolopen Lake T.M. 7.5' (1957), Hudson R. watershed.

608. Pond, unnamed, S side of Rte. 43, 1 km E of West Sand Lake Village, Sand Lake Twp., Rensselaer Co., Averill Park T.M. 7.5' (1980), Hudson R. watershed.

609. Pond, unnamed, S side of Rte. 43, 0.7 km W of Averill Park Village, at Mary Rd., Sand Lake Twp., Rensselaer Co., Averill Park T.M. 7.5' (1980), Hudson R. watershed.

610. Crystal L., NW shore, Lake Rd., Averill Park Village, Sand Lake Twp., Rensselaer Co., Averill Park T.M. 7.5' (1980), Hudson R. watershed.

611. Pond, unnamed, across road from NE shore of Crystal L., 1 km N of Averill Park Village, Sand Lake, Rensselaer Co., Averill Park T.M. 7.5' (1980), Hudson R. watershed.

612. Glass L., Glass Lake Rd., Glass Lake Village, Sand Lake Twp., Rensselaer Co., Averill Park T.M. 7.5' (1980), Hudson R. watershed.

613. Glass L. Outlet, Glass Lake Rd., Sand Lake Twp., Rensselaer Co., Averill Park T.M. 7.5' (1980), Hudson R. watershed.

614. Kinderhook Cr., E shore, 0.2 km W of Nassau-Stephentown Township line, fishing access site, East Nassau Village, Nassau Twp., Rensselaer Co., Nassau T.M. 7.5' (1953), Hudson R. watershed.

615. Kinderhook Cr., Rte. 20-66, 2 km W of Brainard Village, Nassau Twp., Rensselaer Co., East Chatham T.M. 7.5' (1953), Hudson R. watershed.

616. Greens L., SW shore, Athens Twp., Greene Co., Leeds T.M. 7.5' (1953), Hudson R. watershed.

APPENDIX B. WATER CHEMISTRY AT COLLECTION SITES

The following entries are arranged alphabetically by site name (see Appendix A for site locations). Abbreviations: Cond.: conductivity in µmhos/cm; Ca^{++}: calcium ion concentration in ppm; Mg^{++}: magnesium ion concentration in ppm; Na^{+}: sodium ion concentration in ppm; K^{+}: potassium ion concentration in ppm; n.d.: no data.

Site Name (Site No.)	pH	Cond.	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
Allegheny R. (416)	7.0	130	5	3	2	2
Allen L. Outlet (591)	6.9	284	6	2	12	4
Aunt Sarahs Falls & Pool (397)	7.7	398	15	34	18	3
Bad Indian Swamp (396)	7.7	495	20	14	63	4
Bald Mountain Pd. (364)	6.7	230	8	1	35	1
Barber Pd. (279)	6.5	1755	74	12	193	8
Barge Canal (395)	8.0	488	41	19	25	3
Barrett Pd. (295)	6.5	63	7	1	2	1
Beards Creek (405)	7.8	747	54	22	63	6
Beards Creek tributary (406)	8.0	1121	65	24	115	7
Beaver Kill tributary ditch (469)	7.4	75	7	1	1	1
Beaver Meadow Brook (275)	7.1	84	9	1	7	1
Beebe Pd. (294)	8.3	330	33	12	13	1
Belden Brook tributary (477)	7.6	334	12	5	56	4
Big Moose L. (362)	5.2	27	1	1	1	1
Black L. (339)	7.3	226	20	6	6	2
Black L. Creek (467)	7.1	54	1	1	1	1
Black R. (333)	7.2	96	7	1	8	1
Black R. (334)	7.2	96	7	1	8	1
Black R. (366)	6.6	45	5	1	2	1
Black R. (374)	6.9	85	9	1	3	1
Black R. Canal (367)	7.2	105	12	1	4	1
Black R. tributary (335)	7.6	530	50	10	19	2
Bog, unnamed (313)	7.6	212	17	6	7	1
Bowman L. (574)	6.0	83	1	1	2	1
Brown Church Road Pd. (342)	7.7	325	24	24	5	5
Butterfield L. (338)	7.3	139	12	3	40	2

Site Name (Site No.)	pH	Cond.	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
Butternut Creek impoundment (580)	6.6	95	3	1	2	1
Callico Pd. (568)	6.1	83	3	1	1	1
Canacadea Creek (547)	6.5	316	4	10	25	8
Canadarago L. (586)	6.6	313	5	5	9	5
Canadice L. Outlet (513)	8.5	150	9	1	8	2
Canajoharie Creek (596)	7.1	879	10	8	15	12
Canal, abandoned (532)	7.5	2050	94	29	21	5
Canandaigua L. (518A-B)	7.7	301	27	16	13	3
Canandaigua L. Outlet (503)	7.4	670	51	21	36	5
Canandaigua Outlet control pd. (521)	7.5	278	24	16	13	3
Canandaigua Outlet backwater pd. (520)	7.5	278	24	16	13	3
Carter Pd. (320)	7.9	212	33	6	5	1
Casterline Pd. (558)	6.6	452	7	9	60	10
Catamount Pd. (357)	6.0	48	3	1	5	1
Catharine Creek (390)	7.7	419	33	21	19	1
Cayuga & Seneca Canal (527)	n.d.					
Cayuga & Seneca Canal (531)	8.4	600	26	15	92	5
Cayuga & Seneca Canal (534)	8.0	602	26	16	88	4
Cayuga L. (535)	7.9	398	16	15	52	2
Cazenovia L. (562)	6.9	288	7	10	20	6
Cazenovia L. marsh (563)	6.7	288	7	10	20	6
Cemetary Pd. (285)	6.7	118	11	2	7	1
Chamberlain Mills Pd. (317)	7.6	214	35	5	7	1
Charlotte Creek (576)	6.7	232	4	3	2	2
Chateaugay Narrows (350)	6.7	92	8	3	5	1
Chaumont R. impoundment (337)	7.3	520	31	12	10	10
Chautauqua Creek (433)	7.6	398	35	12	18	7
Chautauqua L. (427A-B)	7.3	229	20	7	4	2
Chazy L. (311)	7.8	67	5	2	4	1
Chenango Canal (554)	6.6	283	5	7	22	7
Chenango L. (553)	6.8	229	4	8	8	4
Chenango L. Outlet (552)	6.8	229	4	8	8	4
Childwold Pd. (356)	6.0	150	3	1	24	1

Site Name (Site No.)	pH	Cond.	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
Chittenango Creek (449)	7.5	n.d.				
Chittenango Creek (564)	6.7	422	6	21	26	7
Cincinnati Creek (378)	7.5	230	25	2	7	1
Cincinnatus L. (571)	6.7	90	2	1	1	1
Cincinnatus L. spillway stream (572)	6.4	91	3	1	1	1
Clarke Pd. (592)	7.6	345	6	7	6	4
Cohocton R. (538)	6.1	345	7	12	32	9
Cold Brook (373)	7.1	88	8	2	4	1
Conesus L. (505)	7.4	368	30	15	28	3
Conesus L. Inlet (507)	7.8	359	28	13	24	2
Cranberry L. (354)	5.8	28	2	1	2	1
Crandall Park Pd. (298)	7.1	271	16	4	15	1
Crook Brook Pd. (270)	7.3	188	13	6	7	1
Crystal L. (610)	6.6	198	3	2	39	4
Dead Creek (259)	7.2	371	44	14	10	2
Dead Creek (262)	6.6	87	9	2	4	1
Dead Creek (263)	7.2	371	44	13	10	2
Deep Run (519)	7.6	570	66	22	31	4
Deer L. (475)	9.5	144	3	2	15	1
Delaware R. (458)	8.6	77	2	1	1	1
Delaware R., East Branch (471)	6.9	84	4	1	1	1
Delaware R., East Branch backwater (470)	7.1	242	7	2	45	2
Delaware-Hudson Canal (455)	8.5	86	1	1	1	2
Delaware-Hudson Canal (460)	7.9	240	27	11	1	1
Delaware-Hudson Canal (462)	8.4	156	23	4	1	1
Delaware-Hudson Canal (463)	7.5	70	4	1	1	1
Dillon Pd. (355)	5.6	23	2	1	1	1
Ditch (376)	7.1	284	32	4	10	1
Ditch (410)	7.6	275	26	14	3	1
Ditch (426)	7.9	763	70	23	25	5
Ditch (450)	n.d.					
Ditch (509)	n.d.					
Ditch (522)	7.8	660	44	24	57	4

Site Name (Site No.)	pH	Cond.	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
Ditch (536)	n.d.					
Ditch (548)	6.6	316	6	12	14	6
Ditch into Seneca L. (525)	7.6	1240	58	33	134	7
Ditch into Seneca L. (526)	7.8	760	60	24	88	6
Diversion Channel (394)	8.3	444	19	44	19	2
Eagle Creek (361)	6.2	46	3	1	3	1
East Brook (606)	6.6	245	4	5	21	6
Eighteenmile Creek (441)	7.6	775	50	16	64	8
Erie Canal (443)	7.7	526	41	16	32	4
Feeder Canal - West Canada Creek (380)	7.4	56	6	1	3	1
Findley L. (430A-B)	7.7	234	21	9	1	2
Findley L. Inlet pond (432)	n.d.					
Fishing Pd. (436)	7.8	349	17	16	28	3
Fivemile Creek (544)	6.3	288	6	10	22	7
Flemings Pd. (283)	6.7	42	6	1	1	1
Flint Creek (517)	8.0	368	37	17	17	3
Fourth L. (305)	6.8	68	5	2	4	1
Fourth L. (360)	6.9	52	5	1	3	1
French Creek (431)	n.d.					
French Creek tributary (429)	7.8	706	60	19	41	8
Fuller Hollow Creek (549)	6.5	522	7	8	77	12
Fulmer Creek (589)	6.9	442	7	8	18	9
Galway L. (272)	7.1	223	27	9	7	1
Genesee R. (404)	7.8	401	32	14	20	3
Genesee Valley Canal (415)	7.2	191	25	7	1	1
Geyser Brook (269)	7.4	376	36	9	17	1
Geyser Brook (267)	7.5	345	35	9	13	1
Gilbert L. (579)	6.4	69	2	1	2	1
Glass L. (612)	6.7	110	3	1	35	1
Glass L. Outlet (613)	6.3	128	3	2	8	1
Glen Castle Creek (550)	6.5	327	6	5	45	8
Gleneida L. (212)	7.1	505	14	4	10	2
Glens Falls Feeder Canal (299)	7.3	80	6	2	5	1

Site Name (Site No.)	pH	Cond.	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
Goff Creek (546)	6.4	380	7	14	17	7
Goose Creek (428)	7.8	280	31	10	3	2
Grass R. (344)	7.4	130	9	5	6	2
Great Chazy R. (308)	7.5	173	14	5	7	1
Great Chazy R. (310)	7.0	93	8	3	3	1
Great Sacandaga L. (387)	6.1	48	5	1	1	1
Greens L. (616)	7.2	368	6	5	23	9
Grout Brook (559)	6.7	422	6	15	20	6
Grout Brook (560)	6.8	340	6	15	9	5
Grout Brook (561)	n.d.					
Hemlock L. (511)	7.5	225	20	2	12	2
Hemlock L. Outlet (512)	7.5	225	20	2	12	2
Hennesey Road Pd. (371)	6.8	164	18	2	3	1
Hinckley Reservoir (381)	7.0	58	6	1	3	1
Homowack Kill (461)	7.5	161	17	4	1	1
Hoopes Park Pd. (528)	8.8	260	19	15	18	3
Hudson R. (96A-I)	n.d.					
Hudson R. (286)	7.9	208	29	5	7	1
Hudson R. (301)	7.4	220	14	4	12	2
Hudson R. (603)	7.0	n.d.	5	8	62	21
Hudson-Champlain Canal (312)	7.9	293	41	10	10	2
Johnson Creek (442)	7.9	687	48	19	49	5
Johnson Hollow Stream pond (392)	7.6	261	17	9	25	2
Kayaderosseras Creek (268)	7.8	461	55	9	13	1
Kayuta L. (377)	6.7	43	5	1	2	1
Keuka L. (402)	7.6	312	27	14	11	3
Keuka L. (514)	8.0	236	21	5	8	3
Keuka L. (515)	8.0	236	21	5	8	3
Keuka L. inlet (401)	7.7	308	12	28	16	2
Kinderhook Creek (614)	6.9	179	4	4	8	3
Kinderhook Creek (615)	6.9	173	3	4	10	2
L. Abanakee (276)	6.6	188	10	1	16	1
L. Alice (309)	8.3	158	14	6	4	1

Site Name (Site No.)	pH	Cond.	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
L. Alma (385)	6.4	33	5	1	2	1
L. Champlain (141A-D, 260, 281)	6.9	162	13	5	7	1
L. Champlain (261)	n.d.	142	13	n.d.		
L. Champlain (264)	n.d.	142	n.d.			
L. Cossayuna (319)	7.5	193	16	5	6	1
L. Cossayuna Outlet Pd. (318)	7.5	193	16	5	6	1
L. Durant (277)	6.8	282	13	1	20	1
L. Luzerne (303)	6.6	62	5	1	3	1
L. Ontario, Irondequoit Bay (445A-C)	7.9	1030	58	27	85	5
L. Ontario, Little Sodus Bay (499)	7.3	305	26	11	18	2
L. Ontario, Sodus Bay (502A-B)	7.5	430	36	21	27	3
L. Superior (466)	7.2	60	1	1	1	2
L. Taghkanic (292)	7.0	93	11	2	4	1
L. Tiorati (607)	6.3	62	2	1	16	1
L. Walton (602)	6.6	345	5	7	25	6
Lamica L. (348)	6.7	94	6	3	4	1
Lamoka-Waneta Lakes connecting stream (400)	8.0	498	9	11	2	2
Lansing Kill (368)	7.3	149	17	2	5	1
Lansing Kill (369)	7.3	185	19	2	5	1
Limekiln L. (359)	6.0	27	2	1	1	1
Limestone Brook (418)	6.9	91	2	2	1	1
Little Chazy R. (307)	7.5	254	19	9	8	2
Little Conewango Creek (425)	7.6	286	29	10	2	1
Long Pd. (573)	6.6	91	n.d.			
Lower Chateaugay L. (349)	6.7	92	8	3	5	1
Ludlow Swamp (271)	7.2	297	33	6	12	1
Lyon Mountain Pd. (351)	6.9	400	15	4	49	2
Malone Memorial Recreation Park Pd. (347)	7.0	75	5	2	4	1
Marsh, unnamed (478)	7.7	239	4	2	49	1
Marsh, unnamed (566)	6.6	896	4	28	19	7
Martin L. & Gold Creek (457)	9.2	71	1	1	1	1
Masonic Creek (453)	7.8	332	30	10	28	2
Mead Pd. (575)	7.8	65	3	7	9	12

Site Name (Site No.)	pH	Cond.	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
Meads Creek (539)	6.2	153	6	2	9	4
Melody L. (570)	6.9	90	2	1	1	1
Mettawee R. (315)	8.5	229	36	5	7	1
Middle Farms Pd. (251)	8.6	95	2	1	13	1
Mill Pd. (321)	7.5	42	5	1	1	1
Mirror L. (278)	6.4	124	9	2	12	1
Mohansic L. (604)	6.9	300	4	7	26	8
Mohawk R. (370)	7.8	174	19	4	6	1
Mohawk R. backwater (588)	6.6	413	5	8	22	9
Money Pd. (254)	n.d.					
Montezuma Marsh main pool (533)	8.2	680	40	16	70	4
Moreau L. (297)	7.2	102	12	2	3	1
Moss L. (363)	6.4	33	2	1	2	1
Moss L. (413)	5.5	38	1	1	1	1
Mud L. (545)	6.0	372	6	13	29	9
Neahwa Park Pd. (577)	6.7	188	4	3	6	3
Nettle Valley Creek (516)	7.9	350	43	6	3	2
Neversink R. (454)	7.5	78	2	1	1	1
Neversink R. (456)	7.5	78	2	1	1	1
Newton Creek (391)	7.8	308	28	12	12	2
Niagara R. (437)	7.9	300	27	12	10	2
Niagara R. (438)	7.7	296	27	12	8	2
Nicks L. (365)	5.9	28	1	1	2	1
North McMillan Creek (506)	7.5	570	44	19	53	4
Old Erie Canal (565)	6.4	863	6	26	43	7
Oneida L. (448A-B)	7.5	n.d.	6	9	18	6
Onondaga L. (493)	7.0	2320	89	24	291	8
Oswegatchie R. (341)	7.2	124	9	3	8	1
Oswego R. (495)	7.2	905	44	19	117	8
Otselic R. (556)	6.4	165	4	1	10	4
Otselic R. tributary marsh (555)	6.5	110	4	1	20	4
Outlet of unnamed pond (472)	9.6	260	11	6	26	2
Owasco L. (530)	7.7	282	17	13	8	2

Site Name (Site No.)	pH	Cond.	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
Owasco Lake Outlet (529)	7.7	282	17	13	8	2
Paradox Creek backwater (282)	6.9	160	28	1	4	1
Paradox L. (284)	6.5	68	9	1	4	1
Perch L. (336)	7.7	267	23	71	1	1
Piseco L. (384)	6.7	85	10	2	3	1
Polaris Spring (266)	6.9	201	54	36	181	54
Pond, unnamed (250)	n.d.					
Pond, unnamed (252)	n.d.					
Pond, unnamed (253)	n.d.					
Pond, unnamed (302)	n.d.	90	6	3	5	1
Pond, unnamed (306)	6.9	274	16	6	15	1
Pond, unnamed (314)	7.7	226	18	6	7	1
Pond, unnamed (383)	6.5	68	8	1	2	0
Pond, unnamed (403)	7.7	859	64	34	41	5
Pond, unnamed (411)	7.8	464	54	21	1	1
Pond, unnamed (444)	7.8	531	41	16	32	4
Pond, unnamed (452)	7.5	408	50	12	14	2
Pond, unnamed (459)	8.2	189	19	8	1	1
Pond, unnamed (464)	7.3	302	7	2	54	2
Pond, unnamed (474)	8.0	48	1	1	1	1
Pond, unnamed (494)	7.3	820	35	20	125	7
Pond, unnamed (496)	7.3	680	34	17	83	4
Pond, unnamed (510)	7.7	281	25	5	20	2
Pond, unnamed (523)	8.2	349	36	20	58	2
Pond, unnamed (581)	6.1	80	3	1	2	1
Pond, unnamed (590)	6.5	422	6	4	38	12
Pond, unnamed (594)	7.0	127	4	2	1	1
Pond, unnamed (599)	6.8	365	6	6	22	8
Pond, unnamed (608)	6.7	250	4	6	20	7
Pond, unnamed (609)	6.4	413	4	6	3	13
Pond, unnamed (611)	6.6	367	3	6	20	10
Pumping Station Pd. (280)	7.1	80	8	2	4	1
Pumping Station Pd. (300)	7.3	335	37	6	16	3

Site Name (Site No.)	pH	Cond.	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
Quaker Run, Quaker L. (421)	7.2	80	1	2	1	1
Queechy L. (293)	7.3	297	36	13	9	1
Randolph High School Pd. 1 (423)	7.3	859	33	17	124	5
Randolph High School Pd. 2 (424)	7.6	621	56	18	38	5
Raquette Brook Pd. (274)	7.2	765	61	4	75	2
Raquette R. (345)	6.6	64	4	2	3	1
Rathbun Pd. (316)	7.7	179	17	3	7	1
Red Creek (500)	7.8	498	41	19	34	6
Red House Brook (419)	7.0	85	1	3	1	1
Red House L. (420)	7.1	69	1	1	1	1
Rockland L. (605)	6.3	279	4	6	21	6
Rushford L. (414)	7.3	164	14	5	1	2
Rutland Gorge Stream (332)	7.3	400	44	5	8	2
Rutland L. (331)	7.0	347	39	3	7	1
Salubria L. (543)	6.5	169	6	2	11	5
Sanford L. (542)	6.6	245	4	12	16	5
Saratoga L. (265)	7.3	249	32	6	12	1
Saw Kill (287)	7.6	335	49	5	10	1
Saw Kill tributary impoundment (288)	7.6	315	52	4	6	1
Seneca L. (398)	7.7	805	31	14	107	5
Seneca L. (524A-B)	7.4	760	29	14	122	6
Shadow Brook (595)	7.2	365	7	6	9	6
Shipman Pd. (593)	7.5	367	7	7	8	5
Silver L. (352)	6.7	47	4	1	2	1
Silver L. (582)	6.6	172	4	4	3	1
Silver L. Outlet (407)	7.3	452	35	14	23	3
Silver L. Outlet (408)	7.3	452	35	14	23	3
Silver L. tributary impoundment (409)	7.5	271	25	14	2	1
Sixmile Creek Marsh (439)	7.6	606	34	22	59	4
Sleeper Creek (393)	8.0	412	47	20	6	3
Solon Pd. (569)	5.8	148	3	2	4	4
Sprout Creek (601)	7.1	297	5	6	19	5
Sprout Creek tributary (600)	7.1	257	4	6	15	4

Site Name (Site No.)	pH	Cond.	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
St. Lawrence R. (340)	7.9	359	26	9	22	3
St. Lawrence R. (343)	7.6	520	36	22	20	4
St. Regis R. (346)	7.2	113	7	4	5	1
Sterling Valley Creek (497)	7.7	381	33	18	23	3
Stewart Brook (304)	6.4	69	5	2	3	1
Stillson Pd. Inlet (422)	7.4	248	27	10	1	1
Stissing Pd. (291)	7.1	278	33	9	10	1
Stream, unnamed (585)	6.7	432	10	5	9	7
Stream, unnamed & vernal pd. (451)	8.0	212	13	6	18	2
Sugar R. (372)	8.2	274	31	4	7	2
Susquehanna R. (388)	7.7	251	21	6	7	2
Susquehanna R. (578)	6.0	201	3	3	14	5
Swamp, unnamed (322)	7.1	484	40	7	21	9
Swan L. (468)	6.9	39	1	1	1	1
The Pond (498)	7.4	301	26	11	18	2
Thirteenth L. (273)	7.2	41	5	1	1	1
Thomas Creek (551)	6.6	293	6	8	23	6
Thompson Pd. (290)	7.0	248	34	5	7	1
Tioga R. tributary (537)	6.0	301	4	8	47	7
Tioughnioga R. (557)	6.4	397	7	11	41	9
Tioughnioga R., West Branch (567)	7.3	397	7	8	12	9
Tobehanna Creek tributary (399)	7.8	393	18	10	26	2
Tonungwant Creek (417)	7.0	523	21	10	75	4
Trout Pd. (412)	7.4	369	35	21	1	1
Tupper L.-Simon Pd. marshes (358)	6.3	42	3	1	3	1
Tuscarora Creek (476)	7.9	300	10	6	50	3
Twelvemile Creek, East (440)	7.6	818	46	23	74	8
Typha ditch (508)	7.6	1020	33	5	195	6
Typha ditch (587)	6.6	487	7	8	29	10
Typha marsh (382)	6.5	58	6	1	2	1
Unadilla R. (584)	6.4	368	8	7	8	5
Union Falls Pd. (353)	6.7	67	4	2	5	1
Van Keuren L. (540)	6.3	252	6	11	16	5

Site Name (Site No.)	pH	Cond.	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
Van Keuren L. Inlet (541)	6.5	353	7	14	22	6
Wappasening Creek (389)	7.4	128	7	4	1	2
West Canada Creek (379)	7.4	56	6	1	3	1
West L. Inlet (386)	6.0	54	4	1	4	1
Wharton Creek (583)	6.6	207	5	3	6	1
Whetstone Creek (375)	7.1	77	8	3	2	1
Whitaker Brook Pd. (473)	8.0	46	1	1	1	1
White L. (465)	7.3	77	2	1	3	1
Wide Waters (504)	7.4	640	40	17	67	5
Wilbur Pd. (289)	7.2	149	13	3	10	1
Wolcott Creek (501)	7.7	540	49	20	26	5

Counties of New York State

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Pinophyta (Gymnosperms) of New York State

Edward A. Cope
The L. H. Bailey Hortorium
Cornell University

Contributions to a Flora of New York State IX
Richard S. Mitchell, Editor

1992

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PREFACE

OUR GOAL in producing this series is to present a useful and authoritative account of the plants of New York State. These contributions are intended to reflect the knowledge and taxonomic opinions of specialists who prepare the manuscripts while following a generalized format for consistency. Inclusion of ecological, distributional, medical, and economic information on each species is also one of our major aims. Habitat references, flowering times, pertinent synonymy, etc., often apply specifically to New York plants rather than to the entire species. Complete illustration should facilitate identification of specimens for those who are not formally trained in botany. Descriptions are original, ordered, and as complete as possible to provide sequential cross-referencing.

Distribution maps accompany species of seed plants, ferns, mosses, lichens. These are plotted by counties, to eliminate pinpointing endangered species and habitats, while offering an accurate visual picture of known collections. Maps are based on the master file at the New York State Museum, Albany, and supplemented by available data (specimens examined by the authors) from herbaria housing significant New York collections. Data or literature citations for any map may be obtained, on approval, from the New York State Museum. We hope that these bulletins will serve individuals with interest in the flora, as well as to provide information for State and Federal agencies, conservation organizations, industry and the scientific community. With these works go our hopes for the preservation and wise use of a precious and lifegiving resource—our State's plant life.

The New York State Flora Committee

The steering council of the New York State Flora Committee met for the first time on January 19, 1976, and established as its goals the promotion of study of the State's plant resources and the publication of this series of museum bulletins. These contributions will be continually updated after publication for possible incorporation into larger volumes at a later date.

Members of the council at the time of this publication are:

CONTENTS

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IMPORTANT NOTE

All economic uses, folklore, medical and pharmaceutical notes, uses as foodstuffs, etc., are compiled from the literature and do not represent an endorsement by the authors or the New York State Museum. Some of the uses may, indeed, be dangerous if incorrectly employed. Some are not effective and are presented for historical interest only.

LEGEND

FOR ALL ILLUSTRATIONS, THE FOLLOWING LETTER-DESIGNATIONS APPLY:

A. Male cone(s) (microstrobilus)
B. Male cone scale(s) (microsporophyll)
C. Branchlet bearing male cones
D. Branch or spray
E. Female cone(s) (megastrobilus)
F. Female cone scale(s)
G. Female cone bract
H. Seed
I. Branchlet enlarged with leaves removed
J. Silhouette
K. Vegetative bud
L. Branchlet with juvenile leaves
M. Branchlet(s) enlarged with adult leaves
N. Branchlet enlarged with juvenile leaves
O. Spur (short shoot) and sheath
P. Adult leaves
Q. Linear foliage leaves in cross-section

Pinophyta (Gymnosperms)

The division Pinophyta comprises the classes Pinopsida, Ginkgopsida and Cycadopsida, representing three ancient lineages of trees and shrubs. There are 12 families, over 70 genera and about 650 species of Pinophyta (excluding the Gnetopsida, a class often included in the group). Members of Pinophyta are distinguished from Magnoliophyta (flowering plants or angiosperms), by their naked ovules that may be borne singly or more commonly on structurally complex scales (megasporophylls) of woody or fleshy, compound cones (megastrobili). Secondary characters that also distinguish the group (with occasional exceptions) are absence of vessels in secondary wood, the presence of resin canals, lack of a gynoecium and perianth, and development of pollen-bearing microsporangia on microsporophylls of morphologically distinct strobili.

Conifers (Pinopsida) represent the largest gymnosperm class, with seven families, 65 genera and about 550 species. They are the only group of gymnosperms native to northeastern North America. Three families: Pinaceae, Cupressaceae and Taxaceae, have species native to New York State. A fourth family, Taxodiaceae (baldcypress family), now usually included in the Cupressaceae, is represented by baldcypress, *Taxodium distichum* (L.) Rich., a rare escape from cultivation. The Cephalotaxaceae (plum-yew family) of southeastern Asia is represented in New York State by only two, rarely-cultivated species of *Cephalotaxus*. The Araucariaceae and Podocarpaceae are tropical families grown only under glass in New York State. *Ginkgo biloba* L., ginkgo or maidenhair tree, is a popular cultivated tree worldwide, and the sole surviving member of the ancient group Ginkgopsida. In New York State, planted trees thrive and their seeds may germinate, but often survive only a few years. The third class of gymnosperms (Cycadopsida) is primarily tropical. Several species are widely cultivated, and *Zamia* species are native in Florida, but cycads can be grown only under glass in the northeastern United States.

Conifers are distinguished from other gymnosperms by a combination of characters, including eciliate or non-motile sperm, simple leaves, and microsporophylls in simple strobili. The compound megastrobilus, (often called the "female cone"), consists of few to many scales, called seed-scale complexes (a term that perhaps best labels a controversial and complex structure). A seed-scale complex consists of seeds, an ovuliferous scale and a subtending, minute to prominent bract that is free from, or so completely adnate to, the ovuliferous scale that it is macroscopically impossible to recognize as a separate structure. The ovuliferous scale is a morphologically complex structure consisting of a branch and megasporophylls fused into a single unit, hereafter, in accordance with past usage in most floristic treatments, called the female cone scale. The term, megastrobilus, will here be considered equivalent to the female cone (except in Taxaceae, where the megastrobilus cannot be called a cone). The microstrobilus and microsporophyll will be referred to here as male cone and male cone scale, respectively.

During the Mesozoic Era, spanning over 200 million years, the gymnosperms and their relatives occupied most of the habitable surfaces of the earth. Today's gymnosperms represent only a remnant of the diversity of that era. Although there are only about 650 species (less than one quarter of 1% of the plant species in the world), the gymnosperms still occupy a disproportionately large land surface and have great ecological and economic significance.

KEY TO FAMILIES

1. Female reproductive structure a solitary, globose ovule or seed partially enclosed by a red, fleshy aril, with megasporophylls or cone scales not discernible; leaves flattened, cuspidate or acuminate. .... 1. **Taxaceae**
1. Female reproductive structure a conical, oblong or globose, woody or fleshy cone; ovules (1-) several to many; cone scales obvious (except *Juniperus*), peltate or flattened and oblong; leaves scale-like or linear and flattened, usually acute .... (2)
   2. Female cone conical or oblong-cylindrical, the scales oblong or flabellate, 25 or more; leaves arranged so that the branchlet is visible, linear or linear-lanceolate, much longer than wide; leaf completely visible .... 2. **Pinaceae**
   2. Female cone globose, conical or oblong-cylindrical, the scales peltate or oblong, 12 or less; leaves appressed, the bases completely clothing the branchlet, subulate or mostly scale-like, nearly as wide as long, closely imbricate so that the leaf is only partially visible .... 3. **Cupressaceae**

Taxaceae (Yew Family)

The Taxaceae: a family of five genera and 23 species with a significant degree of reproductive specialization, the most noteworthy example of which is a unique, fleshy, berry-like aril that partially surrounds the seed. This structure is currently considered to be a reduced compound strobilus (Chamberlain, 1935; Hart, 1987; Keng, 1969; Wang et al, 1979; Wilde, 1975). Although members of the family are distributed primarily in the Northern Hemisphere, the monotypic genus, *Austrotaxus*, is native in New Caledonia, and *Taxus wallichiana* Zucc. [*T. sumatrana* (Miq.) Delaubenf.] occurs in Indonesia. Taxad species are

often of wide-ranging, but with remarkably disjunct distributions. *Pseudotaxus* (a monotypic genus), *Amentotaxus* and most members of *Torreya* occur in China, while *Taxus*, the largest genus, is represented in North and Central America, Europe and Asia. Florida and northwestern North America each have a single native species of *Taxus* and *Torreya*, but, in northeastern North America, the family is represented only by *Taxus canadensis* Marshall. *Torreya taxifolia* Arn., the stinking cedar or Torrey pine of Florida, is nearly extirpated in the wild, but grown occasionaly ornamentally in southeastern states. It was once utilized for fence posts. The Chinese Torreyas are harvested for their lumber, and *Torreya californica* Torrey, California nutmeg, is grown ornamentally. *Taxus* species are among the most widely planted shrubs for ornamental purposes, with numerous cultivars having been developed (Cope and Vance, 1991). The seeds and foliage are poisonous to man and some mammals.

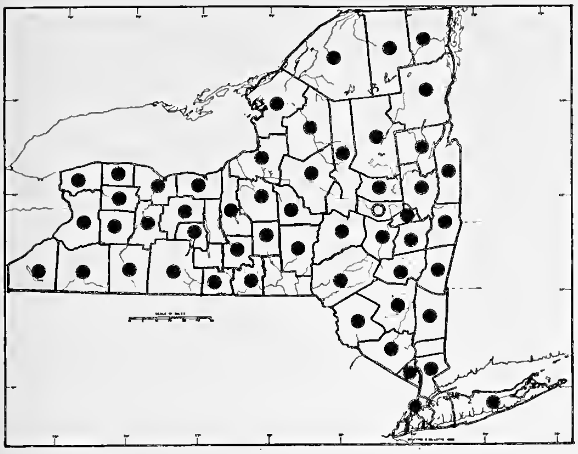
FAMILY DESCRIPTION

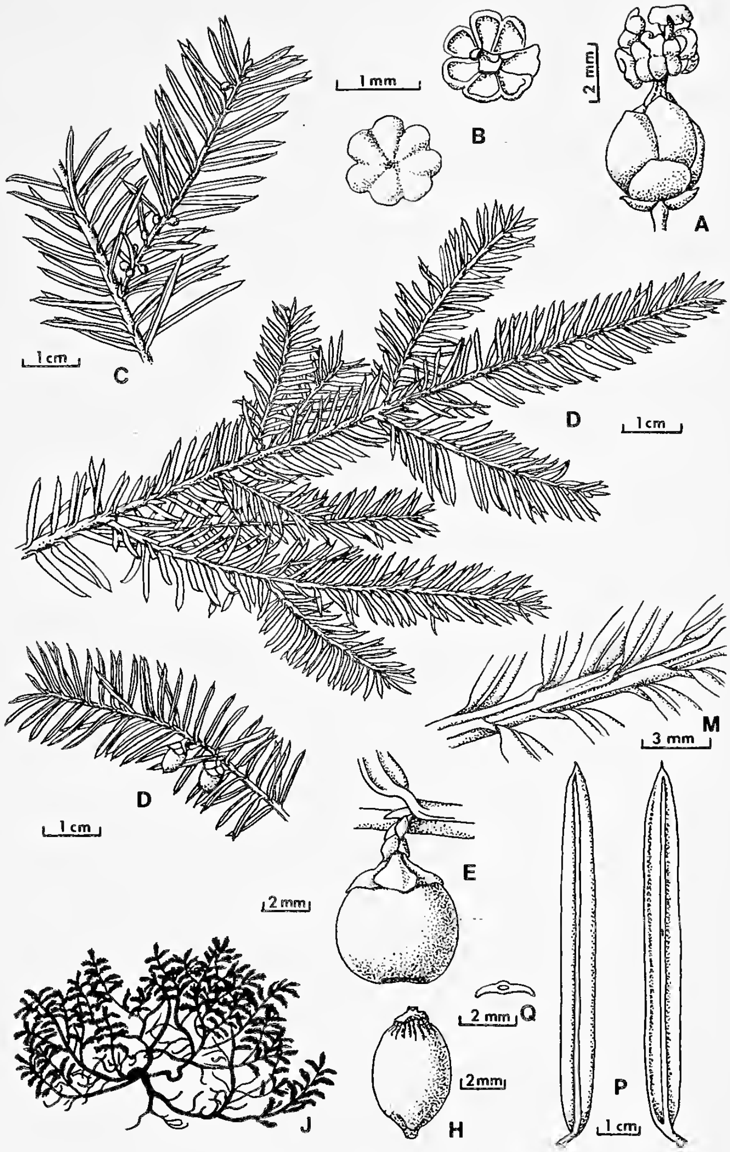
Evergreen shrubs or small (to large) trees, the Taxaceae have sinewy, red, dark purple or brown branches covered with green (later brown), decurrent leaf bases. The leaves are usually alternate and 2-ranked, bifacially flattened, linear to linear-lanceolate, short-petiolate, attenuate, cuspidate (or acuminate), papillose, with revolute margins and no resin canals. The adaxial surface of the leaves is lustrous, dark green with the midrib raised or not, and the abaxial surface is yellow-green with a longitudinal band of stomata on each side of the midrib. The species of Taxaceae are mostly dioecious, but our native species, *Taxus canadensis* Marshall, can be monoecious as well. Male cones are axillary, solitary (in ours) or in 2-4 terminal or subterminal racemes, sessile or minutely peduncled, globose or often becoming oblong or conical, the sterile scales 8-many, the fertile male cone scales 3-numerous and peltate; microsporangia (2) 3-9, and pollen grains lack bladders or wings. The megastrobilus (the term "cone" cannot be applied to the female reproductive structure in Taxaceae) consists of a solitary ovule that is terminal on a short axillary shoot or peduncle with 6-20 subtending, persistent, spirally arranged or opposite and decussate sterile scales. The seed is dry and hard, surrounded partially or completely by a green, purple, white or red aril. The aril is a fleshy part of the megasporophyll that develops from the axis (ovuliferous scale) or apex of the ovule-bearing axillary shoot. The embryo has two cotyledons. The diploid chromosome number is 24 or 22 (*Taxus*).

1. TAXUS

Common Name: yew
Authority: Linnaeus, Species Pl., II, p. 1040, 1753

Taxus is a genus of 10 species (and 2 artificially derived hybrids) of shrubs and small trees, distributed primarily in the Northern Hemisphere. *Taxus brevifolia* Nutt., grows in western North America, and it is potentially important in cancer research. The endangered species, *T. floridana* Nutt. ex Chapm., Florida yew, is the only native in the southeastern United States, while the more common *T. canadensis* Marsh. is the native yew of northeastern North America. The genus is taxonomically difficult because of variability and the overlapping nature of the limited morphological features used to distinguish species. Yew is of immense horticultural importance, since these shrubs are planted in great numbers worldwide for a wide range of ornamental purposes, but mostly planted next to buildings or as hedges. At least 300 cultivated varieties have been developed and named. The older of these varieties are cultivars of *T. baccata* L., which is much-cultivated in Europe. The limbs of *T. baccata* have proved to be excellent material for bows, and the wood makes fine furniture. New York's only native species, *T. canadensis*, is exceptional in that its irregular, elongate and spreading growth habit does not adapt itself well for ornamental use, and it is also the only species where monoecious plants are reported in an otherwise dioecious genus. *Taxus baccata* L. of Europe and *T. cuspidata* Sieb. & Zucc. of Japan have been reported as rare escapes from cultivation in New York. The artificial hybrid, *T. cuspidata × canadensis* (*T. × media* Rehd.) has now become the most popular yew, with the greatest number of cultivars in the current North American nursery trade (Cope & Vance, 1991).





1. *Taxus canadensis* Marshall

Common Names: Canadian or American yew, ground-hemlock, dwarf yew, shinwood, creeping hemlock

Type Description: Marshall, Arbust. Amer., p. 151, 1785

Synonyms: *T. baccata* ssp. *canadensis* Pilger, *T. baccata* var. *minor* Michx., *T. baccata* var. *procumbens* Loudon, *T. minor* Britt.

Origin: Native to northeastern North America

Habitats: Rich woods, thickets, swamps, bogs and ravines, especially on north-facing slopes, in a variety of soils, generally moist, cool, partially to fully shaded situations

Habit: Shrub with many spreading, ascending (or pendulous) branches, often a sprawling, rather open bush, the branches, prostrate, rooting, forming open to dense thickets

Pollination: April-May

Mature Aril and Seed: July-September of the 2nd season

General Distribution: Newfoundland to southeastern Manitoba and northeastern Minnesota and Iowa, south to northeastern Virginia, West Virginia, Northeastern Kentucky, eastern Ohio, Michigan and northeastern Iowa; disjunct in northeastern Kentucky, west-central Indiana and southeastern Iowa

Description: Plants **monoecious** or **dioecious**; **megastrobili** solitary, occasionally paired, axillary on the second (or third) year branchlets, nearly sessile; **peduncle** about 1 mm long, covered with scales or scale-like leaves; **female sterile scales** 15-18, appressed, imbricate, membraneous, the lower (basal 9) ovate, concave, about 1 mm long, acute, pale brown to transparent, the remaining 6-9 broadly ovate to flabellate, 1.5-2.5 mm long, 3-4 mm wide, transparent or light green, often rugose; **aril** nearly enclosing the ovule, globose or subglobose, 6-8 mm long, about 6 mm wide, hard and green when young, fleshy and bright red when mature, dispersed or drying and deciduous the first year; **seed** ovoid, about 5 mm long, 4 mm wide, apiculate, mostly 2-angled near the apex, brown, lacking wings; **cotyledons** 2; **male cones** solitary, scattered in axils of leaves on first-year branchlets, erect, globose before expansion, then short oblong-cylindrical, about 4 mm long, 2 mm wide, green to yellow-green; **peduncles** sometimes concealed but usually surpassing the bud scales, 2-4 mm long, scaly at the base, naked towards the apex; **male sterile scales (bud scales)** 8, decurrent on the basal 1/3-1/2 (1.5-2.0 mm) of the peduncle, loosely and partially covering the upper 1 mm of peduncle, scarious, glabrous, entire, the basal 2 keeled, gibbous, somewhat hardened or indurate, 1.5-2.0 mm long, the remaining 6 broadly ovate 1.5-3.0 mm long, 2-3 mm wide; **male cone scales** 6-8, peltate; **stalk** less than 0.2 mm long;

lamina orbicular, about 0.5 mm in diameter; **microsporangia** 4-9, longitudinally dehiscent, about 0.2 mm long; **pollen** lacking wings or bladders; **leaves** crowded, 2-ranked, pectinate, forming a deep V along the upper side of the branchlet, linear, abruptly narrowed at the petiole, blades 1.0-1.5 (-2) cm long, 1.5-2.3 (-3) mm wide, cuspidate, glabrous, entire, the margins incurved, **adaxial surface** dark green, the midrib inconspicuously to prominently raised, lacking stomata, **abaxial surface** concave, dull, yellow-green, with a longitudinal band of stomata on each side of the dark green, raised midrib, stomatal bands about 0.2 mm wide or twice the width of the midrib and green margins, usually consisting of 6 rows of stomata; **petioles** 0.5-1.0 mm long, broadened into a decurrent base; **buds** ovoid, conical or obovoid, 2-3 mm long, the lateral buds smaller, green to red-brown; **bud scales** imbricate, appressed, keeled, acute or obtuse, hardening and turning brown, persisting for several years; **branchlets** covered by the decurrent bases of the leaves and therefore green the first year, green or red-brown the second and third years, red-brown to gray-brown thereafter, the decurrent leaf bases eventually shedding; **branches** spreading or ascending, the lower ones often pendulous at the tip, prostrate and rooting; **bark** scaly, red-brown to brown; **shrub** to 2 m tall, mature plants with many ascending, spreading and pendulous branches; **roots** dark, fibrous, often adventitious (2n = 24).

Importance: The genus *Taxus* is of immense importance in ornamental horticulture, but *T. canadensis* is little-used for ornament because of its sparse, sprawling growth habit. Only a few cultivated varieties of this species have been developed. The pulp of the red aril is sweet and edible, and can be used for jams. The seeds and other parts of the plant, however, are strongly toxic to humans. Extreme caution should be exercised, since ingestion of leaves, stems, seeds or roots of yew can result in poisoning by taxane derivitives, yielding a rash, weakness, coma, gastroenteritis, diarrhea, dizziness, heart arrhythmia and possible death due to respiratory failure.

Infraspecific Variation: Although *T. canadensis* is often reported to be monoecious in floras, manuals and other literature, field observation and examination of hundreds of herbarium specimens have yielded this author no affirmation of the monoecious condition. There is remarkably little morphological variation within the species outside of growth habits of individuals. Distinctions between this and other members of the genus *Taxus* are sufficiently vague that all yews have sometimes been considered to be subspecies of a monotypic genus. Widely separated geographic ranges and the convenience of listing historically recognized taxa seem largely responsible for the maintainance of separate species within the group.

Pinaceae (Pine Family)

The Pinaceae: a worldwide, primarily north temperate family of 10 genera and about 200 species. The genera are well defined, often displaying highly specialized characteristics. The largest genus, *Pinus* (ca. 100 spp.), is a diverse group of species occurring in a wide variety of habitats, almost entirely in the Northern Hemisphere. The other larger genera, *Abies* (39 spp.), *Picea* (34 spp.), *Tsuga* (10 spp.) and *Larix* (11 spp.) are mostly found at high elevations or in boreal forests. *Pseudotsuga* (5 spp.) grows in western North America and eastern Asia, while *Cedrus* (4 spp.) is found in the Himalayas, northern Africa and the Mediterranean Region, and the remaining three genera (*Cathaya*, *Keteleeria*, *Pseudolarix*) are endemic to China. The five largest genera are represented in the native flora of northeastern North America, including New York State. *Pseudotsuga menziesii* (Mirb.) Franco (Douglas-fir), the great lumber tree of western North America, also widely cultivated for ornament and Christmas trees, has been recorded as a rare escape from cultivation in the Northeast. *Cedrus* species are popular as cultivated plants in warm parts of the United States, but have a limited cultivated distribution in New York. *Pseudolarix* is mostly found only in botanical gardens in North America. Members of the pine family dominate a number of forest types of the North Temperate Region, including vast expanses of tiaga and montane forest, and they are prominent in many second-growth, often fire-related, ecosystems as well. Utilization of Pinaceae for lumber and pulp continues to be an industry of great economic importance. Members of the family are also planted extensively for Christmas trees, and cultivars for ornamental use have been developed from most genera (Cope, 1986). Turpentine and other products of the resin are extracted from the trees, and edible seeds of some pines are harvested and marketed.

FAMILY DESCRIPTION

Trees of the Pinaceae are long-lived, monoecious, evergreen (deciduous in *Larix* and *Pseudolarix*), often very tall (reaching heights of 90 meters or more), with spire-like or conical, spreading to dense or open, crowns that may be irregular to quite symmetrical. The trunks reach diameters of two meters and are often devoid of branches for 1/3-2/3 their height under shaded forest condition with dead branches occasionally persisting. The yellowish-brown, red-brown or gray to black bark is smooth or roughened by thin, flaking scales or deeply furrowed with thick, sometimes corky scales. Branches are slender to stout, rigid or brittle, ascending to horizontal or pendulous, and, in some species, capable of rooting when in prolonged contact with the sub-

strate. Branchlets may be terete and smooth or more commonly ridged and grooved, or roughened from the decurrent, often raised and persistent leaf bases, glabrous or pubescent, the trichomes rusty, brown or gray, sometimes glandular. A greatly reduced or dwarfed branchlet called a spur or spur shoot is present in some genera, persisting two to several years, growing at the rate of only about 0.5 mm per year (ceasing growth after one year in *Pinus*), and bearing annual rings formed by scars of the scarious, often persistent, bud scales. Buds are small and globose or ovoid to large and oblong-cylindrical, red-brown with many appressed scales, the tips of the outer scales sometimes spreading. Leaves are bifacially flattened (bilaterally flattened in *Cedrus* and some species of *Picea*), and are of one or two kinds on the same plant. Juvenile leaves, when present, are usually scarious (linear and green in *Larix* and *Pseudolarix*), deciduous or persistent for several years in a reflexed, brittle, flaking condition, the bases hardened, decurrent and often raised on the branchlet. Adult leaves are sessile or raised on woody, projected decurrent bases, spirally arranged on the branchlet or in clusters of 2 to many on spur shoots. They are linear, angled or flattened, emarginate or obtuse to acute, often pungent, sometimes glaucous, pale green, gray-green, blue-green to dark green, glabrous, entire or minutely serrulate, aromatic, amphistomatic or hypostomatic, with 1-12 resin canals and one or two vascular bundles. Male cones are solitary, small (2-13 mm long), globose or more commonly oblong-cylindrical and loosely or tightly clustered at the base or extending halfway up the first-year branchlets (and sometimes older ones). The short, naked or scaly peduncles of the male cones are loosely and partially (or completely) concealed by the subtending or basal, persistent, scarious sterile scales. These scales are the male cone bud scales, and are attached in a compact spiral cluster where the peduncle joins the branchlet. The 10-180 male cone scales are roughly L-shaped, with 2, small (1-2 mm long) microsporangia that are surpassed at the apex by an apical flap, connective or lamina (rarely merely a knob or beak) that projects at right angles and upward, so that its abaxial surface is exposed, parallel to and facing away from the cone axis. The microsporangia dehisce transversely, obliquely or mostly longitudinally. Pollen grains are numerous, with or without 2 bladder-like wings. Male cones typically wither, turn brown and fall in the first year, but sometimes persist into the second year. The female cones are solitary and initially erect, remaining so or becoming horizontal or pendulous. The short peduncles are usually are soon concealed by the reflexed basal scales. From the time of initiation, female cones require 12-28 months for the process of pollination and fertilization to be completed and for mature seeds to be dispersed, though some closed-cone pines retain their seeds in unopened cones for years, the empty cones often persisting whole on the branchlet for many years, or only the axis persisting, and the scales individually deciduous. Female cone scales are sessile, flabellate or suborbicular to oblong, thin or thick, often apically thickened, green or red-purple becoming brown at maturity, glabrous and entire or erose. Each scale is subtended by a concealed or exserted, minute or long-flabellate, spatulate or oblong, erose or lacinate, often subulate-tipped bract. In *Pinus*, the bract soon fuses with the scale, and bracts often reach their full size long before the cone is mature and are exserted at this early stage. Two ovules are borne at the base of each adaxial surface of the scale and are inverted with the acute or two-pronged apex and micropyle facing the cone axis. The seeds are obovate, rhombic, angled or flattened, with or without resin vesicles, usually with an oblique, wedge-shaped, membranous, pale brown, often striated wing. Cotyledons are 3-16 in our species. The diploid chromososme number is 24 almost without exception (2n = 44 and 2n = 26 have been reported for *Pseudolarix* and *Pseudotsuga*, respectively by Khoshoo, 1961).

KEY TO GENERA

1. Adult leaves in clusters of 2-40 ....(2)
1. Adult leaves solitary ....(3)
   2. Adult leaves in clusters of 2-5 (-7), the bases enveloped in a sheath; mature female cones greater than 3 cm long, the scales 50 or more ....1. *Pinus*
   2. Adult leaves in clusters of 25-40 at the end of short spur branchlets; mature female cones less than 2 cm long, the scales 10-20 ....2. *Larix*
3. Female cone bracts long-exert, 3-pronged; buds acuminate, at least twice as long as wide ....3. *Pseudotsuga*
3. Female cone bracts concealed or short-exsert, rounded at apex; buds globose, as wide as long or nearly so ....(4)
   4. Female cones erect, scales falling separately, leaving the naked cone axis still attached; leaves flattened, leaving circular indented leaf scars on the branchlet, bark not coming away with the leaf when detached ....4. *Abies*
   4. Female cones pendulous when mature, scales falling as a unit; leaves angled or flattened, leaving raised, woody pegs on the branchlet, bark or wood coming away with the leaf when detached ....(5)
5. Leaves flattened, of several sizes and orientations on the branchlet, obtuse or emarginate, minutely denticulate towards the apex, hypostomatic; the leading shoots flexible and pendulous ....5. *Tsuga*
5. Leaves angled, of approximately the same size and orientation on the branchlet, pungent (prickle-tipped) or acute, entire, amphistomatic; the leading shoots erect ....6. *Picea*

1. PINUS

Common Name: pine
Authority: Linnaeus, Species Pl. II, p. 1000, 1753

Pinus is the largest conifer genus, comprising about 100 species, almost entirely distributed in the Northern Hemisphere. Although pines are often considered to be primarily successional elements in mixed deciduous forest zones, they are also major forest components of montane and some lower elevation forests in western North America, and from coastal southeastern states south to Mexico. About 35 species occur in the United States and Canada, 38 in Mexico, 15 in Europe, 23 in Asia and three in North Africa. Six species are native in New York State, where second-growth white pine (*P. strobus*) occupies only a small portion of the area once covered by previous large expanses of white pine forests that developed after clear-cutting in the late 18th and 19th centuries. The genus is easily divided into two large subgenera. The hard or diploxylon pines (subgenus *Pinus*) have two vascular bundles per leaf, mostly with persistent sheaths and leaves mostly borne in clusters of two or three, while the more primitive, soft or haploxylon pines (subgenus *Strobus*, represented only by *P. strobus* in New York State), are characterized by leaves in clusters of five or more (five in *P. strobus*) with one vascular bundle per leaf and deciduous sheaths. In addition to the widely planted and escaping *P. sylvestris* L., scotch pine, *P. thunbergiana* Franco, Japanese black pine, and *P. nigra*. J. Arnold, Austrian pine, of Europe have been reported as rare escapes from cultivation in New York. Pines are important worldwide for use in reforestation, as Christmas trees, timber, and as ornamental conifers. The wood is used for building materials, pulpwood for the paper industry, and it is extracted for resins, from which turpentine and other products are manufactured. Edible seeds of some pines are gathered and marketed as "pine nuts."

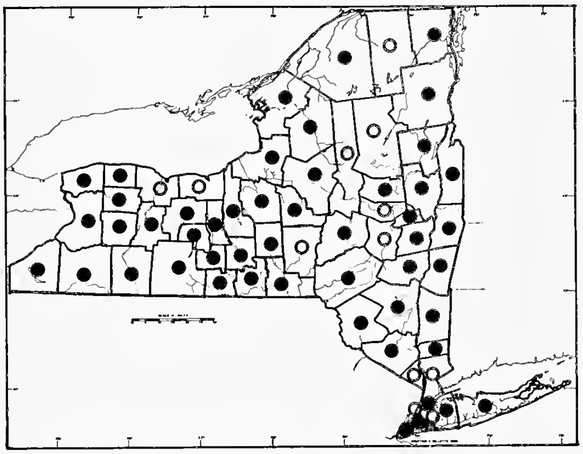
Description: monecious; reproductive cycle: female cones are initiated in early fall, but not visible until the following spring, when they open for the first time by a slight separation of their cone scales; pollination then occurs, but fertilization requires an additional year, during which the female cone remains closed and grows larger; male cones develop each year at the base of new-growth of terminal shoots; the female cone matures and opens for the second time in the fall, a full two years after initial development. Seeds may then be shed, or, in some species, they may remain within closed (serotinous) female cones for years; **female cones** solitary or in whorls of 2-4; **at pollination**: erect or horizontal, globose or subglobose or short conical, pink, green, yellow-green or usually dark purple; **after pollination** (prior to the second opening): horizontal or pendulous, narrowly conical, green, yellow-green or light brown; **at maturity:** horizontal or pendulous, conical, ovoid-conieal or subglobose, red-brown to dark brown, usually turning gray when weathering over many years, persisting 1-30+ years after maturity (in some species overgrown by the outer trunk or branch bark); **peduncles** 2-20 mm long, visible at pollination, usually later becoming concealed by the basal scales; **bracts** flabellate or obovate, minute, scarcely 1 mm long, erose or minutely denticulate, soon becoming fused to and macroscopically indistinguishable from the scale; **female cone scales** numerous (60-120 in ours), spirally arranged, oblong, concave, thick (5-20 mm long, 4-15 mm wide in ours), light brown to dark red-brown, glabrous, entire; **apophysis** (thickened rhombic or diamond-shaped exposed part of the abaxial surface) usually light yellow-brown, weathering to dark brown or gray, often with a transverse line or ridge across the surface; **umbo** (darker point or boss near the center of the apophysis) unarmed or armed with a straight, spreading, reflexed or incurved **prickle**, the prickle usually with a broadened base, deciduous or persistent; **basal cone scales** nearly half the total number of scales, reduced, mostly remaining closed, more reflexed, their apophyses generally thicker and more mounded or acute, the prickles, if present, persistent and usually longer; **apical cone scales** reduced in width, the uppermost pair usually not separating (together forming a vertical cylinder at the apex of the cone); **ovules** 2-pronged, the prongs slightly exserted to each side of the cone scale base; **seeds** obovate, rhombic, wedge-shaped but with rounded sides, (3-6 mm long in ours) the base acute, the apex rounded or obtuse, usually light or dark brown, mottled with black, glabrous, lacking resin, winged; **wing** obovate, rhombic or wedge-shaped, obliquely attached to the seed at the base, the apex oblique or rounded (6-15 mm long, 4-6 mm wide in ours), but with one side angled, membraneous, pale brown, often with dark or red-brown striations; **cotyledons** 4-15; **male cones** tightly and spirally clustered at the base of the first-year branchlet (long shoot), globose or subglobose and stiff at first quickly expanding to become oblong-cylindrical, flexible, often curving or twisting after pollen release, drying, turning brown and deciduous the first year or sometimes persisting into the second year; **sterile scales** 4-10, scarious with transparent margins, red-brown, glabrous, loosely covering the peduncle up to or slightly surpassing the most basal male cone scales, the basal sterile scales 1-2, ovate, about 2 mm long, keeled, indurate, the others ovate, acuminate, longer; **peduncle** erect at first and remaining so or becoming horizontal or pendulous, naked after expansion, usually less than 1 mm long; **male cone scales** numerous (30-180 in ours), spirally arranged, sessile, yellow-brown to red-brown, glabrous; **lamina** projecting at right angles from the stalk and microsporangia, flabellate or orbicular, about 1 mm in diameter, the margins minutely laciniate; **stalk** nearly completely concealed by the microsporangia; **microsporangia** attached to the stalk, dehiscing longitudinally; **pollen** reticulate, 2-winged; **leaves** dimorphic: **juvenile leaves** solitary, either foliar or scarious; **foliar juvenile leaves** appearing only on the first year seedling after the cotyledons, linear (1-4 cm long in ours); **scarious juvenile leaves** subtending adult leaf clusters, linear-lanceolate to ovate-lanceolate, (1.5-12.0 mm in ours), red-

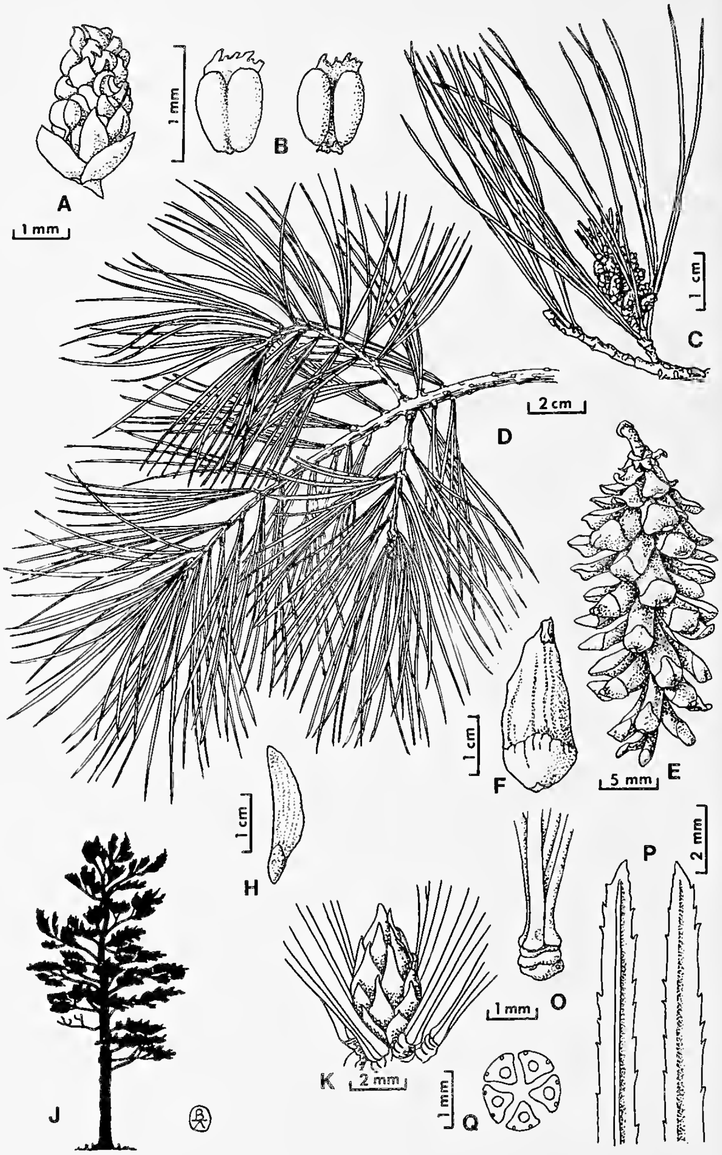
brown to brown or blackened if persistent, becoming dried and brittle and often reflexed or coiled back, deciduous in the first year or persisting for several years before flaking off, leaving raised, decurrent bases or scars on the branchlets; **adult leaves** (1) 2, 3, or 5 (-8) in a cluster at the apex of the spur (reduced branchlet), linear, 2-15 cm long (in ours), 0.5-2.0 mm wide, acute, bright green to gray green, with 2-18 median or marginal resin canals, deciduous with the spur (after 2-5 years in ours), **adaxial surface** flat, slightly or strongly concave (appearing strongly concave in dried specimens), or with a longitudinal, usually serrulate angle or ridge projecting towards the center so that there are 2 surfaces, with a total of 6-20 longitudinal rows of stomata, **abaxial surface** convex or flat, with 6-18 longitudinal rows of stomata; **sheath scales** (bud scales of the spur buds) 8-12, crowded in the axil of the juvenile leaf, subtending adult leaf cluster, scarious, ovate to oblong or obovate, increasing in length and transparency from base of the spur outward, 1-22 mm long, red-brown, glabrous, with transparent, long-fimbriate, partially-fused margins, the threads or filaments interweaving, persistent, soon encircling the spur tip and the base of the adult foliage leaves to form the sheath; **sheath** becoming tighter with the addition of the following year's sheath scales (in diploxylon pines), becoming ragged at the apex with the spreading and tearing of the first-year sheath scales, 2-9 mm long, usually gray or black, deciduous with the spur and the adult or foliage leaves; **buds** ovoid to oblong-cylindrical, large, acute or obtuse, greatly expanding as the long shoot elongates and the first adult leaves appear, usually very resinous, the resin in white or amber accumulations sometimes completely covering the bud, usually red-brown, enveloped in the long transparent threads of the fimbriate margins of the scales; **bud scales** (which become the scarious juvenile leaves) many, tightly appressed, ovate to lanceolate, about 2-9 mm long (in ours), acuminate, scarious, the outer tips usually spreading and sometimes reflexed, red-brown, glabrous, the margins transparent and fimbriate; **branchlets** dimorphic; **long shoots** thin and flexible to stout, yellow-green to red-brown, pale-brown or dark brown to gray, glabrous, rough to the touch due to the persistent juvenile leaves or leaf bases, the bases raised 1-2 mm on the branchlet, decurrent, forming conspicuous to inconspicuous grooves or ridges the first and second year, then spreading and forming wide striations on the branchlet and finally separating into rectangular, truncate scales that gradually flake off, the branchlets ultimately less roughened or nearly smooth; **spurs** (abbreviated branchlets or short shoots) borne in the axils of the juvenile leaves, about 1 mm long, gray, glabrous, ringed by scars of the caducous sheath scales (in *P. strobus* and other haploxylon pines, and a few diploxylon pines) or completely covered by the persistent sheath scales, bearing the adult leaves at the apex, persistent 2-5 or more years, falling with the adult leaves still attached, leaving a circular or transversely elliptic scar about 1 mm long on the long shoot; **bark** smooth or scaly on young trees, fissured or scaly sometimes forming thick corky plates on older trees, yellow-brown, red-brown to gray or dark brown; **branches** usually long horizontal, ascending in young plants, spreading, often slender, usually brittle (short and stout in *P. resinosa*); **crown** conical to narrowly conical, round-topped or open and irregular; **trunk** typically 25-100 cm in diameter, devoid of branches in the lower portion or clothed to the base depending upon habitat, shrubby or usually **trees** 2-30 m tall; **root systems** usually with a deep taproot, with wide-spreading, stout, woody lateral branches that may be shallow or deep with age.

KEY TO SPECIES

1. Leaves (needles) in clusters of 5; sheaths deciduous; female cones pendulous, 8-20 cm long .... 1. *P. strobus*
1. Leaves in clusters of 2 or 3; sheaths persistent; female cones horizontal or erect (rarely pendulous), 3-8 (-10) cm long ......(2)
    2. Leaves nearly all in clusters of 2 .... (4)
    2. Leaves mostly in clusters of 3 (less often 2) .... (3)
3. Leaves flexible, 2 or 3 per cluster; sheaths usually more than 5 mm long; young branchlets glaucous; peduncle of female cone about 4 mm long (plants rare in NY) .... 2. *P. echinata*
3. Leaves stiff, 3 per cluster; sheaths about 5 mm long; young branchlets not glaucous; peduncle of female cone 7-10 mm long .... 3. *P. rigida*
    4. Leaves mostly less than 7.5 cm long; mature sheaths mostly less than 5 mm long .... (6)
    4. Leaves mostly greater than 7.5 cm long; sheaths mostly greater than 5 mm long .... (5)
5. Branches slender, flexible; young branchlets glaucous; leaves 2 or 3 per cluster, merely folding when bent; mature sheaths mostly less than 8 mm long .... 2. *P. echinata*
5. Branches thick, stout; young branchlets not glaucous; leaves consistently 2 per cluster, snapping or breaking when bent; sheaths mostly greater than 8 mm long .... 4. *P. resinosa*
    6. First-year branchlets (long shoots) not glaucous; female cones mostly less than 4.5 cm long; leaves mostly twisted 1/4 - 1/2 turn .... (8)
    6. First-year branchlets (long shoots) glaucous; female cones mostly greater than 4.5 cm long; leaves straight or twisted 1 and 1/2 turns .... (7)
7. Leaves twisted (ca. 1.5 turns), occasionally 3 to a cluster; mature sheaths 5-8 mm long; juvenile leaves persistent, 1.0-1.5 mm long; female cone scales armed with persistent or deciduous prickle .... 2. *P. echinata*

7. Leaves not twisted, straight, 2 per cluster; mature sheaths 3-6 mm long; female cone scales armed with deciduous prickle; juvenile leaves deciduous, 3-4 mm long .... 5. *P. virginiana*
   8. Female cones often remaining closed, pressed against the branchlet, often contorted or incurved, unarmed; leaves 2-4 cm long, mostly less than 1.5 mm wide; resin canals 2; mature sheaths 1.5-2.5 mm long; juvenile leaves 1.5-3.0 mm long; bark dark brown, not flaking .... 6. *P. banksiana*
   8. Female cones closed only when young, not pressed against the branch, not contorted, straight, armed with a deciduous prickle; leaves 4-9 cm long, at least 1.5 mm wide; resin canals more than 2; mature sheaths mostly 5 mm long; juvenile leaves 7-8 mm long; bark red, flaking from upper branches and trunks .... 7. *P. sylvestris*





1. *Pinus strobus* L.

Common Names: white pine, eastern white pine, Weymouth pine, deal pine, American deal pine, northern white pine, American white pine, New England pine, sapling pine

Type Description: Linnaeus, Species Pl. II, p. 1001, 1753

Synonyms: *Strobus weymouthiana* Opiz, *S. strobus* (L.) Small

Origin: Native to eastern North America

Habitats: Occasionally in pure stands, but usually scattered in mixed woods or old field borders, on rocky, well-drained soils and slopes at low elevation, particularly prominent on open west- and south-facing slopes, also in swampy woods, along edges of swamps, bogs and on river banks and north-facing slopes with hemlock, less often growing in wetlands or moist, sandy soils with *P. rigida*. Found on a variety of soils throughout the State, but growing best on well-drained soils, with an ability to compete with brush in openings caused by fire or windthrow and on dry sites and poorer soils. An important overstory tree in well-developed deciduous forests, especially between northern and southern hardwood forest-types. The most mesophytic of our eastern pines, with its relative dominance apparently controlled by the tolerance of associated, competitive species to local edaphic and climatic influences after fire and other disturbances

Habit: Medium to large tree, forming a broad, symmetrical conical crown when young, the long lateral branches sweeping upwards in graceful curves, the crown breaking up when older, becoming irregular, wind-swept and asymmetric, typically with loss of limbs producing large gaps. In crowded forest conditions, branches shorter, forming a narrow crown that over-

tops the mature deciduous forest canopy. Trunks usually straight with little taper and clear of branches under forest condition, or lower branches persisting in open conditions, often forked or tapered upward

Pollination: May-June

Mature Cones Opening: September-November of the 2nd season

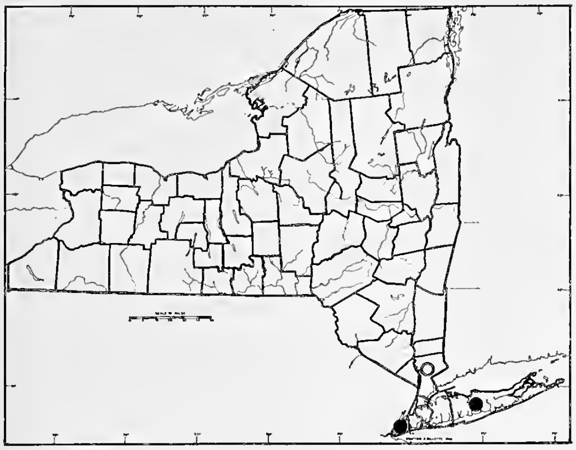
General Distribution: Newfoundland to southeastern Manitoba, south to northwestern South Carolina, northern Georgia, eastern Tennessee, eastern Kentucky, eastern Ohio, northwestern Indiana, northern Illinois and northeastern Iowa; disjunct in Delaware, eastern Virginia, central Noreth Carolina, central Tennessee, western Kentucky, western Indiana and central Iowa

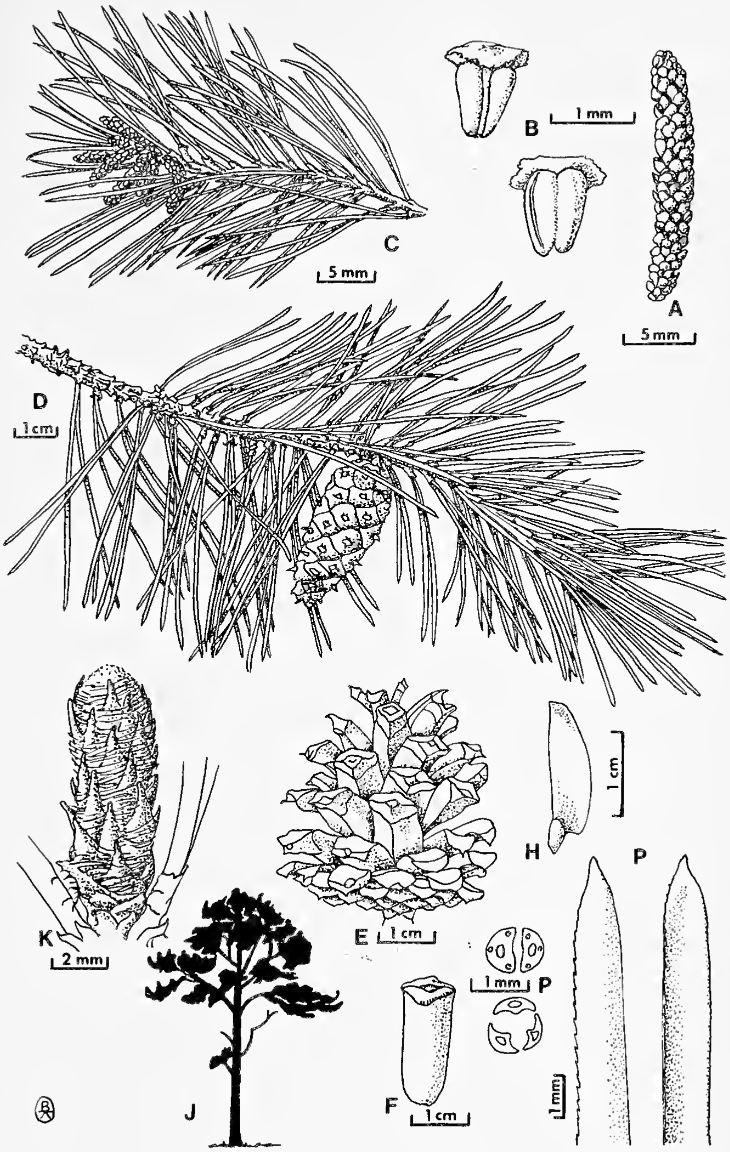
Description: monoecious; **female cones** usually solitary, occasionally paired, axillary, erect when young, pendulous when mature, on peduncles at the base of the previous year's branchlets, oblong-cylindrical, tapered at the apex and base, (8-) 10-15 (-20) cm long, about 2.5 cm wide when closed, 4-6 cm wide when open, purple when young, becoming light brown, weathering gray, usually persisting 3 years; **peduncle** (11-) 15-20 (-30) mm long, about 2 mm in diameter, clothed with awl-shaped scarious, red-brown leaves that are strongly decurrent with spreading tips, grooved, dark red-brown to dark brown when mature, glandular-pubescent, the glandular hairs mixed with other longer scattered or densely matted hairs, some hairs early deciduous; **female cone scales** 60-70, spirally arranged, obovate, concave, about 20 mm long, 15 mm wide, thin, glabrous, entire, red-brown to dark brown, the apical scales 5-10 mm long and narrower, basal scales short-oblong or ovate, 8-10 mm long, about 5 mm wide; **apophysis** flabellate, slightly thickened, pale brown to yellow-brown, later becoming gray; **umbo** unarmed, the raised apex rhombic, often crinkled or folded back, glaucous and purple at first, becoming dark brown; **seeds** elliptic to ovoid, narrowed at both ends, slightly angled, about 6 mm long, 3-4 mm wide, red-brown to dark brown, usually mottled with black spots, **wing** oblong, obliquely angled at the apex, joining the seed body at an angle, 20-22 mm long, about 6 mm wide, pale gray or pale brown, striated black or brown, surpassed by the scale by 3-4 mm; **male cones** 25-40, in compact clusters, covering the basal 1.5-3.0 cm portion of the first-year branchlet, globose and about 4 mm in diameter before pollen release, soon becoming oblong-cylindric, slightly tapered at the apex, 8-9 (-15) mm long, 3 mm wide, purple to dark red-brown or brown, deciduous the first year; **sterile scales** 6-7, ovate, obovate or oblong, 3-5 mm long, with a thick, dark red-brown midrib, the basal scales lanceolate and aristate; **male cone scales** 30-40, spirally arranged, 1.5-1.8 mm long, 1.0-1.4 mm wide, **lamina** not evident before release of pollen, inconspicuous afterward, broadly triangular, about 0.2 mm long, 0.3-0.4 mm wide, acute or laciniate at the apex; **foliar juvenile leaves** 1-2 cm long, with 2-4 longitudinal rows of stomata on each surface; **scarious juvenile leaves** 2-3 mm long; **adult leaves** 5 per cluster, 3-angled, **adaxial surfaces** connivent only for about 2 mm at the base, then divergent, 5-10 (-14) cm long, 0.4-0.7 mm wide, acute, green or light green often with a blue or gray tint, lower margins entire becoming minutely and remotely denticulate toward the middle and upper third of the leaf, the teeth longer and more divergent towards the apex, slightly aromatic, deciduous, together with the spur after the second year, adaxial surfaces 2, each with 2 longitudinal rows of stomata at the base, 2-3 rows in the middle and 3-5 rows near the apex, sometimes with the midrib or angle minutely serrulate, **abaxial surface** flattened or slightly convex, with 2 marginal resin canals faintly visible as thin, pale, longitudinal lines, lacking stomata, slightly aromatic, deciduous after the second year; **sheath scales** usually 8, scarious, acute, concave, folding around the expanding adult leaves, light brown to light red-brown, the lowermost ovate, basally indurate, about 3 mm long, third, fourth and fifth scales ovate, 3-5 mm long, fifth, sixth and seventh scales ovate-lanceolate to oblong, 6-10 mm long, eighth or uppermost scale linear-oblanceolate, 11-18 mm long; **sheaths** deciduous by the end of the growing season, leaving scars in rings on the spur at the base of the adult leaf cluster; **buds** ovoid-oblong, about 5 mm long, terminal buds usually longer and larger than the lateral, acuminate, brown or red-brown, slightly resinous; **bud scales** numerous, ovate, 3-4 mm long, the basal scales 1 mm or less long, ca, 1.5 mm wide, long-acuminate to aristate, the tips spreading or appressed, red-brown, glabrous, entire; **branchlets (long shoots)** 2-5 mm in diameter, light brown to red-brown and orange-tomentose when young, becoming glabrous and dark brown, gray-brown or gray, smooth, marked by the slightly raised, transversely elliptical scars of fallen spur shoots and the truncate, 1 mm long, 2 mm wide, dried, brown, flaking remnants of juvenile leaves; **spurs** often directed forward along the long shoot, about 1 mm long, gray or dark brown, with 3 circular grooves or rings, revealed by the early-deciduous sheath scales, deciduous together with the adult leaves in the second year; **branches** slender becoming stout, brittle, horizontal, in regular whorls of 5, irregular on older trees; **bark** 3-5 cm thick on older trees, thin and smooth becoming shallowly or deeply fissured with broad, longitudinal scaly ridges, green tinged with red becoming dark gray; **crown** broad, symmetrical, conical when young, breaking up when older, becoming irregular and asymmetrical with large gaps left by branches that are easily destroyed by weather, the branches shorter, forming narrow crown in forest conditions, the long lateral branches sweeping upward in graceful curves; **trunks** to 1 (-2) m in diameter, straight with little taper and usually clear of branches in the forest, often forked and greatly tapered, clothed to the base with branches in open conditions, the tree reaching 30 (-70) m in height; **root system** widely spreading, deep to shallow lateral roots, lacking a taproot, but wind firm with sinker roots (2n = 24).

Infraspecific Variation: Variation is limited in white pine of eastern United States, the variable leaf length and density often

reflecting soil or climatic factors. The Mexican variety, *P. strobus* var. *chiapensis* Martinez has finer leaves and a different placement and number of resin canals. The length of the peduncle of the female cone, leaf length and leaf spacing are perhaps the most variable characters that can cause confusion when contrasting characteristics of similar species. *Pinus strobus* is geographically isolated in range from closely related or superficially similar species, such as *P. monticola* Dougl., *P. wallichiana* A.B. Jacks., *P. ayacahuite* Ehrenb., *P. koraiensis* Sieb. & Zucc., and *P. flexilis* E. James.

Importance: White pine was once a dominant forest tree in New York, but a combination of 19th Century cutting and 20th Century hardwood reforestation has rendered it a far less conspicuous element today. The weak, light-weight, straight-grained, easily-worked wood is light in color and only slightly resinous. These characteristics once made it the most important lumber tree in northeastern North America. The estimated 750 billion board feet of white pine lumber once available in northeastern forests was almost completely removed by the beginning of the 20th Century for use in nearly every product from ship masts and matches to furniture, shingles, clapboards, doors, flooring, framing, covered bridges, furniture bracing, trim and crates. Although it was principally used domestically, vast quantites were also exported to the West Indies and Europe. White pine is planted for reforestation purposes because of its rapid growth as well as the quality of its lumber. Through planting efforts and natural regeneration, third- and fourth-growth white pine forests now produce a steady, although much smaller supply of lumber, of relatively small dimensions. White pine is commercially important as a Christmas tree and ornamental, with several important cultivars and many other growth forms having been developed. The inner bark, seeds, young shoots and even the closed young cones have been used as foods by early colonists and Native Americans. All parts of the tree were also used for a plethora of concoctions for healing and nutrition, the most notable of which is the white pine tea made from the leaves, which contain copious amounts of vitamin C. The cones, seeds, bark, and occasionally the leaves, provide food for birds, squirrels, deer and rabbits. The disease, white pine blister rust, is a common disease of white pine caused by an introduced fungal pathogen (*Cronartium ribicola* J.C. Fisch.), which requires gooseberry or currant (*Ribes* spp.) as an alternate host to complete its life cycle. It has had such deleterious effects on white pine populations that planting certain *Ribes* species is outlawed in some states, and it is recommended that no gooseberries be planted near white pine stands or plantations. An insect pest, the white pine weevil [*Pissodes strobi* (Peck)], destroys the terminal leader, retarding reforestation efforts and discouraging wider use of white pine as a Christmas tree.





2. *Pinus echinata* Miller

Common Names: shortleaf pine, old-field pine, shortstraw pine, Arkansas or North Carolina pine

Type Description: Miller, Gard. Dict. ed. 8, no. 12, 1768

Synonym: *P. mitis* Michx.

Origin: Native to the southeastern United States

Habitats: Tree of old fields and sandy savannahs of the Coastal Plain, growing on poor, dry, sandy or rocky soils, in pure stands or intermixed with hardwoods. Native to New York only on Staten Island and extreme southeastern counties

Habit: A medium to large tree with slender, often pendulous branches in regular whorls, forming a broad, conical, rounded or truncate crown, with slightly tapering trunk, often clear of branches for at least half its length at maturity

Pollination: April-May

Mature Cones Opening: Variably in the 2nd season

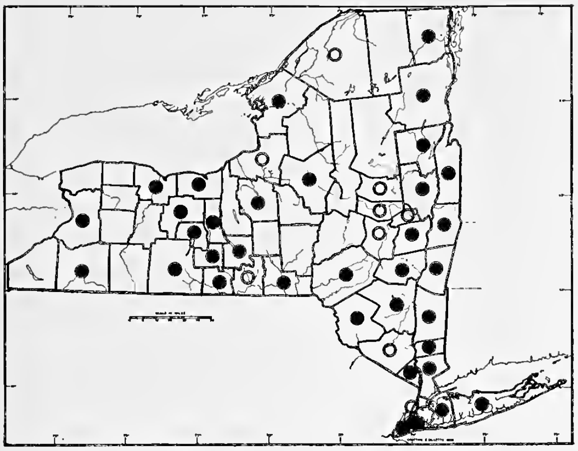
General Distribution: Southeastern New York west to eastern Oklahoma, south to northwestern Florida along the Gulf Coast to eastern Texas

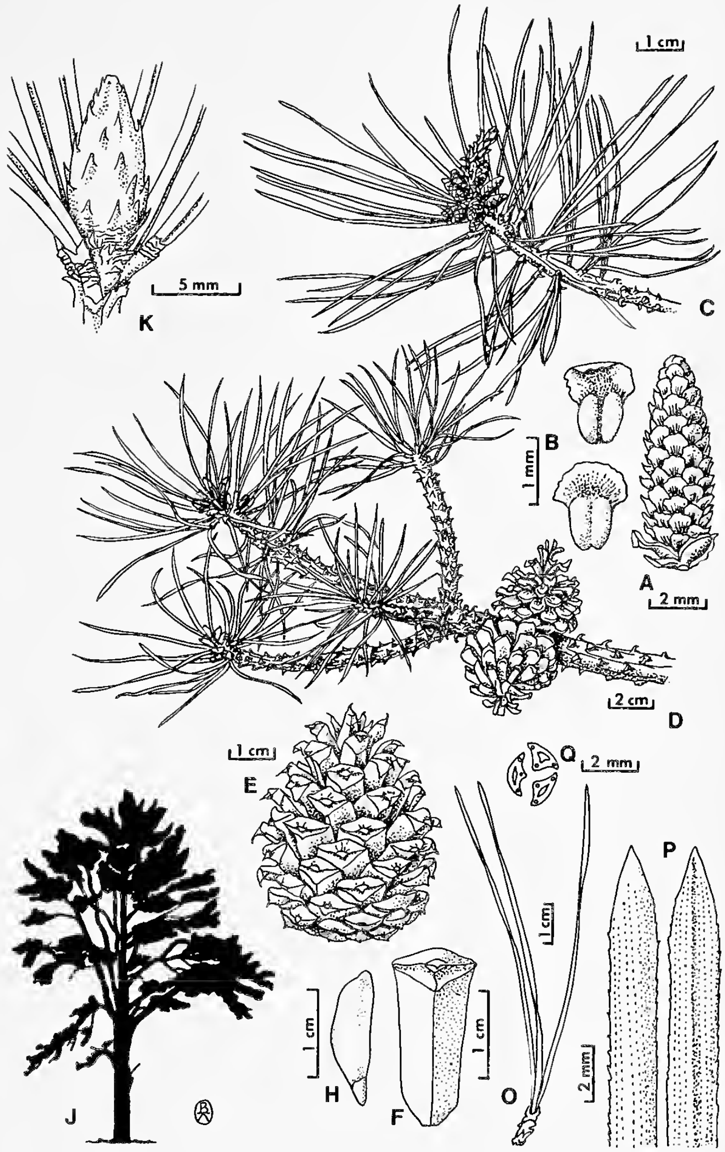
Rarity Status: The Natural Heritage Program lists this species as SH (State historical). It is believed to have been extirpated from the State as a native plant, since no populations have been relocated in the past 15 years

Description: monoecious; female cones 2-4, rarely solitary, arranged in whorls at the base of the current season's growth, symmetrical, ovoid or conical the first year, narrowly conical the second year, broadly conical or ovoid to subglobose thereafter, 4-6 cm long, 3-5 cm wide at maturity, light red or pink at pollination becoming light red-brown and finally brown when open, weathering gray-brown, persistent for several years; **peduncle** horizontal, scaly, about 4 mm long, 5-6 mm in diameter; **female cone scales** 60-80, spirally arranged, oblong, slightly incurved near the apex, concave, 18-25 mm long, the adaxial surface brown, abaxial surface dark brown, the uppermost 2-4 scales not fully developed, scales gradually reduced toward the cone base, those at the extreme base only 2-3 mm long; **apophysis** rhombic, wider than high, about 5-7 mm high, 9-10 mm wide, light yellow-brown to brown, thickened with a sharp transverse ridge through the middle or rather flattened with a more rounded less prominent ridge; **umbo** bearing a prickle 0.5-1.5 mm long that is usually deciduous (but persistent on the lower scales and a few of the upper scales), the prickle directed outward or downward toward the branchlet, leaving a circular to transversely elliptical gray scar upon falling; **seeds** rhombic, their sides broadly rounded, 4-6 mm long, about 3 mm wide, the apex obliquely obtuse,

base acute or obtuse, brown, usually mottled black, **wing** obovate or oblong, the apex obliquely obtuse or rounded, 1.5-2.0 cm long, light brown with dark brown striations; **male cones** 8-14, covering only about 1 cm of the branchlet base, globose or subglobose prior to pollen release, becoming oblong-cylindrical, about 5 mm in diameter prior to pollen release, then to 2.5 cm long, 3.0-3.5 mm wide, pale purple or yellow, turning red-brown to brown; **sterile scales** 10, concealing the peduncle and lower male cone scales, red-brown to pale brown with fringed, transparent margins, the basal pair broadly ovate, gibbous, strongly keeled, ridged or winged, indurate, the next 2-3 scales obovate, about 3 mm long, 2 mm wide, the remainder broadly ovate, 4-5 mm long; **male cone scales** 150-180, spirally arranged, crowded, 1.5-1.8 mm long, 0.8 mm wide; **lamina** flabellate, 1.0-1.2 mm long, about 1.2 mm wide, the rounded apex and margins finely serrulate to laciniate and transparent, light red-brown; **microsporangia** about 1.5 mm long, 0.8 mm wide; **scarious juvenile leaves** 1.0-1.5 mm long, apex ovate, often persisting for 3-4 years; **adult leaves** usually 2, sometimes 3 (-4) per cluster, (5-) 7-8 (-13) cm long, 0.8-1.0 mm wide, acute, serrulate, persistent, usually for 2, but as long as 5 years, resin canals 2-3, median, **adaxial surface** concave with strongly incurved margins or, when leaves in clusters of 3, with sharply raised minutely and remotely serrulate angle, stomata in 6-9 longitudinal rows, **abaxial surface** convex with 8-14 rows of stomata; **sheath scales** 12, red-brown with transparent margins, in a series from base outward, ovate to increasingly lanceolate and fringed or fimbriate, the basal pair ovate, gibbous, keeled, semi-indurate, about 1.2 mm long, the next pair broadly ovate, about 2 mm long, the third pair about 3 mm long, the fourth pair fimbriate, 4-6 mm long, the fifth pair spathulate, about 8 mm long, and the final pair lanceolate, nearly 1 cm long, almost entirely transparent; **sheath** becoming tighter with age, blackened and ragged at the apex, 5-8 mm long, falling with the spur leaving a circular to transversely elliptical scar in the axil of the raised, persistent base of the juvenile leaf; **buds** oblong-cylindrical, acute, 4-9 mm long, lateral buds smaller, brown with a gray tinge due to the interwoven, fimbriate upper margins of the scales, marked by red-brown longitudinal lines from the darkened, acuminate apices of the scales; **bud scales** many, closely imbricate and appressed, ovate-lanceolate, 6-9 mm long, acuminate, upper margins long-fimbriate forming a light web around the bud; **branchlets (long shoots)** brittle, about 2-3 mm in diameter the first and second year, becoming 4-5 mm or more in diameter thereafter, roughened in the first three years by the crumpled juvenile leaves and thereafter by the persistent, raised, decurrent juvenile leaf bases, the bark beginnning to separate into large scales containing several decurrent leaf bases and flaking off after the third year, pale green, purple or red-brown, glaucous the first year, becoming dark red-brown, then dark brown; **branches** in regular whorls, long, slender, stiff, horizontal, sometimes slightly pendulous; **bark** 1.5-2.5 cm thick, with distinct fissures and large, irregular, scaly plates covered with small, closely appressed scales, light cinnamon-red; **crown** broadly conical, rounded or truncate; **trunk** up to 1 m in diameter, slightly tapering, often clear of branches for at least half its length, but free-standing wolf trees common in old fields with widely spreading lower branches and branch stumps; **tree** 30-40 m tall; **root system** with a very deep taproot, even in mature trees (2n = 24).

Importance: This is an important lumber tree of the southeastern United States. The wood of shortleaf pine is heavy, hard, strong, coarse-grained and resinous, used extensively in house construction and furniture manufacturing. The tree is planted for reforestion, in large plantations for production of pulp, and as a lawn or park tree in the south. Although not particularly fire resistant, *P. echinata* coppices up from the roots and stumps in burned-over areas. It is a major element in old-field succession over a wide portion of its range.





3. *Pinus rigida* Miller

Common Names: pitch pine, torch pine, sap pine, yellow pine, southern pine, black Norway pine, candlewood pine

Type Description: Miller, Gard. Dict. ed. 8, no. 10, 1768

Origin: Native to eastern North America

Habitats: Dry, rocky soil, gravelly uplands and sandy plains. Common on glacial soils, thriving in pine barrens and coastal dunes, often on sites of former glacial lake shores in upstate New York, the relative abundance depending on repeated fires and availability of poor soils. Without periodic fire, replaced by white pine or hemlock (oaks in more southern climates)

Habit: A small to medium-sized tree with horizontal branches, forming an open, wide, rounded or irregular crown, the trunk clear of branches in the lower third, or with well-developed lower branches, sometimes forming "skirts" at ground level in beach habitats. The trees are often wind-swept, with wand-like, flagging branches, especially in pine barrens, but trees may appear more uniform, less gnarled and contorted on more fertile soils

Pollination: April-May

Mature Cones Opening: Sporadically after 2 seasons

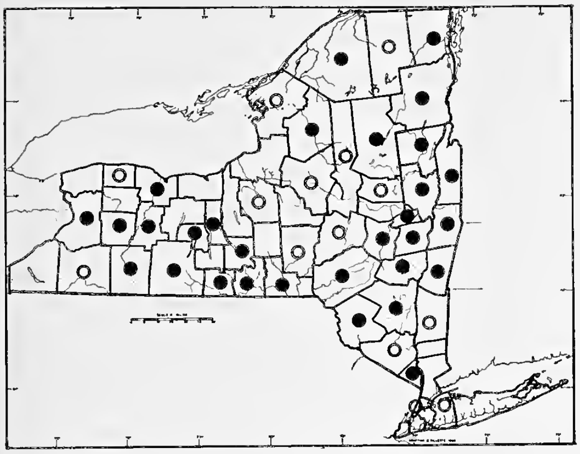
General Distribution: Southeastern Maine west to eastern Ontario, south to northwestern South Carolina, northern Georgia, eastern Tennessee, eastern Kentucky and southeastern Ohio; disjunct in central North Carolina and central and western Kentucky

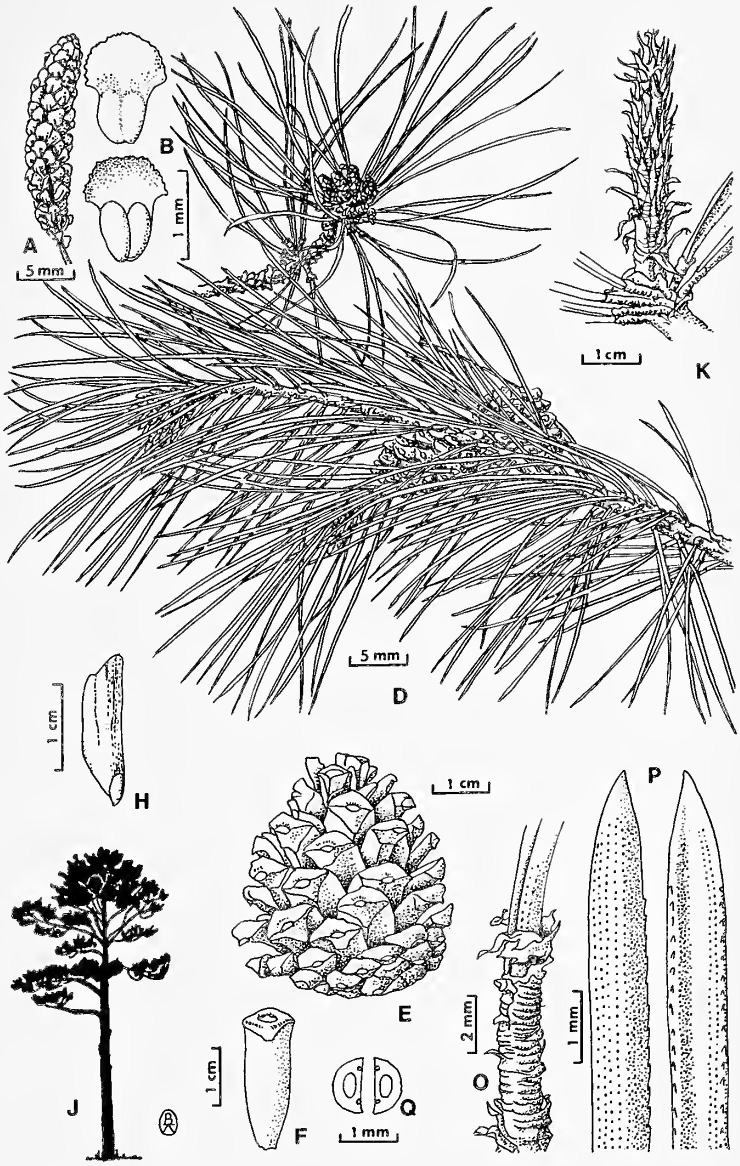
Description: monoecious; female cones solitary or 2 (-4), first appearing at the apex of the previous year's growth on lateral branchlets, erect prior to pollination, becoming horizontal or projecting at right angles from the branchlet, ovoid to subglobose, 4.5-7.0 (-10) cm long, (3-) 4-6 cm wide, green prior to becoming red-brown at pollination, then light brown and shiny, finally weathering gray, serotinous or non-serotinous, persistent as long as 12 years; **peduncles** 7-10 mm long, 3-6 mm in diameter, scaly; **female cone scales** about 100, oblong, sometimes obovate, the upper ones ascending, the lower horizontal, reflexing with age, slightly incurved along upper margins near the apex, slightly bulging on lower margins just below the middle, 12-25 mm

long, 8-11 mm wide, light brown to red-brown on the adaxial surface, dark red-brown or dark brown on the abaxial surface; **apophysis** asymmetrically rhombic, 7-12 mm wide, light brown to yellow-brown; **umbo** truncate, 2.5-4.0 mm wide, pungent, armed with a stiff, straight or curved, persistent prickle, the prickle 1-2 mm long, projecting outward or downward; **seeds** about 4 mm long, 2 mm wide, acute at the base, obliquely angled and acute at the apex, thick, rounded on the sides, roughened, black, sometimes mottled brown, **wing** ovate-oblong, 10-13 mm long, 4-5 mm wide, broadest below the middle, gradually narrowed to an oblique apex, pale brown; **male cones** about 20, spirally arranged in a tight cluster on the basal 2-3 cm of the first year branchlet, oblong-cylindrical, (8-) 15-20 (-30) mm long, 4-6 mm wide, red-brown, deciduous in the first year; **sterile scales** 4-8, ovate, 3-5 mm long, acute, red-brown with darker brown midribs, basal scales long-acuminate; **male cone scales** about 150, spirally arranged, about 2 mm long; **lamina** flabellate, about 1 mm long, 1.0-1.5 mm wide with rounded apex, margins minutely denticulate, red-brown, white or transparent at the margins; **microsporangia** about 1 mm long, 1-1.2 mm wide; **juvenile leaves** strongly decurrent, soon drying and reflexing or rolling back with age, linear-lanceolate, 7-8 mm long, long-acuminate, red-brown, margins transparent and often fringed; **adult leaves** almost always 3 to a cluster, each twisting about one complete turn over its length, directed forward past the apex of the spur, often parallel to the branchlet or long shoot, spreading and becoming nearly perpendicular with age, rigid, (5-) 8-10 (-13) cm long, 1.0-1.5 mm wide, acute, light green, margins and midrib serrulate, persistent 2-3 years, resin canals (2-) 3-4 (-7), median, **adaxial surface** with a sharply raised, minutely serrulate midrib (or angle) and 12-15 rows of stomata, **abaxial surface** rounded to convex with about 13 rows of stomata; **sheath scales** 9-10, imbricate, acute, basally light green, apically light red-brown, the transparent margins fused and encircling the spur and base of the adult leaves, the basal 3-4 scales ovate, 2-5 mm long, mostly with only the basal margins fused, other scales ovate-lanceolate to lanceolate, 5-10 mm long, margins fused their entire length; **sheath** usually about 5 mm long to the point where it meets the branchlet at the base of the spur shoot, black with ragged, membraneous fringes; terminal **buds** sometimes concealed by the leaves, ovoid, oblong-ovoid or oblong, obtuse or acute, 5-16 mm long, the lateral buds usually smaller, obtuse or acute, resinous, red-brown, the long transparent fringes of the scale margins giving the bud a lighter, sometimes hairy appearance; **bud scales** appressed, only their tips slightly spreading, ovate, acute, 3-4 mm long, red-brown, margins scarious, fringed; **branchlets (long shoots)** stout, 3-6 mm in diameter, orange-brown the first year, becoming brown the second year, dark brown, gray-brown or black thereafter, roughened from the persistent base of the juvenile leaf or the juvenile leaf itself, narrowly grooved, at first from the decurrent juvenile leaf bases, becoming broader, sometimes darker or gray, the decurrent leaf bases eventually separating into scales that flake off; **branches** in regular, distant whorls, horizontal, ascending or pendulous, rigid, stout, thick, short, gnarled and contorted with age; **bark** 2-4 cm thick, thin, with red-brown, plate-like scales when young, later deeply fissured into flat, scaly, anastomosing ridges that separate into thin or thick, dark red-brown scales; **tree** up to 25 m tall, with horizontal branches forming an open, wide, rounded or irregular **crown**; **trunk** up to a meter in diameter and often clear of branches in the lower third, but often with adventitious sprouts; **root system** relatively shallow, but with a taproot when young ($2n = 24$).

Infraspecific Variation and Hybridization: Cones may be serotinous or not, depending on fire history of the habitat. Variation may be significant between individuals, including fire-adapted features and leaf length and spacing. Pitch pine hybridizes naturally with *P. taeda* L. (loblolly pine), *P. serotina* Michx. (pond pine) and *P. echinata* elsewhere, but hybrid trees have not been reported from New York State. Most growth forms of *P. rigida* can be attributed to edaphic considerations and wind and winter ice damage, with the likely exception of diminutive trees of the "Dwarf Pine Plains" in the pine barrens of New Jersey, Suffolk County, Long Island, New York, and the Shawangunk Mountains in Ulster County. A case has been made for a genetic component that is at least partially responsible for the consistent differences displayed in these dwarf trees (Good and Good, 1975; Ledig and Fryer, 1974; Little, 1972; Olsvig, 1980; Olsvig *et al.*, 1979). These characteristics include a greater percentage of serotiny in the female cones, contorted stems with prostrate branches, short annual internodes, and massive root crowns (Olsvig, 1980). The adaptation for survival to frequent fires is obvious in contrast with typical pitch pines, which are also fire-adapted but for less frequent occurrence of fire. A formal botanical variety for dwarf pitch pine has yet to be described and named. A few cultivated varieties popular in dwarf conifer gardens have recently been developed and named.

Importance: Pitch pine was historically important in production of charcoal, and the wood was used as a fuel. The light, soft, weak, brittle, coarse-grained wood is durable and rot-resistant. It has been used in manufacture of vessels, flooring, water wheels, aqueducts, sills and framing, as well as for rough lumber and crate-building material. Lampblack, tar and turpentine have been derived from the resin, and the knotty resin-filled branches were used as torches and fire-starting wood by early Americans. Pitch pine has little importance as an ornamental. The trees do not compete well with most forest species, but easily tolerate poorer soils, and can become weedy and quickly dominant in open, oak-pine associations. Their ability to resist fire, to coppice up after burns and to withstand salt spray and accumulation are remarkable among conifers. With progressing development in New York State, scattered pitch pines remain as lonely representatives of former pine-barrens vegetation, and the species is becoming well known as a weedy colonizer of recently disturbed, poor sites.





4. *Pinus resinosa* Aiton

Common Names: red pine, Norway pine, hard pine, Canadian pine

Type Description: Aiton, Hort. Kew., vol. 3, p. 367, 1789

Origin: Native to eastern North America

Habitats: Scattered in coniferous or hardwood forests, occasionally forming open groves or rarely in pure stands, thriving on gravelly ridges, on sandy plains and other areas of poor soil; rarely found in low, wet ground. A tree that can not compete well with brush or white pine on most sites. In New York State, common on sandy soils near the Adirondacks, less frequent on dry, flat areas or benches in the central and, rarely, the western part of the State. Also a component of pine barrens vegetation in Clinton County. It may be more common in parts of the State today because it was massively planted for timber and reforestation purposes during much of the 20th Century

Habit: A medium-sized tree with stout, spreading, sometimes pendulous branches that form a broad, often round-topped crown, the trunk straight with little taper, usually devoid of branches for at least half its length when growing in forest habitat

Pollination: April-June

Mature Cones Opening: September of the 2nd season

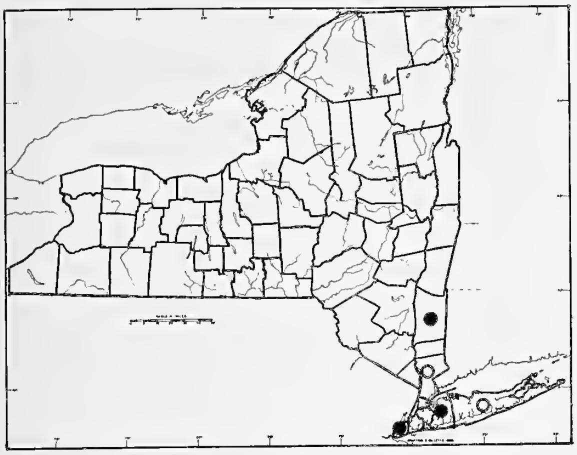
General Distribution: Nova Scotia west to southern Manitoba, south to northern New Jersey, northern Pennsylvania, northern Michigan, Wisconsin and eastern Minnesota; disjunct in Newfoundland, West Virginia and northern Illinois

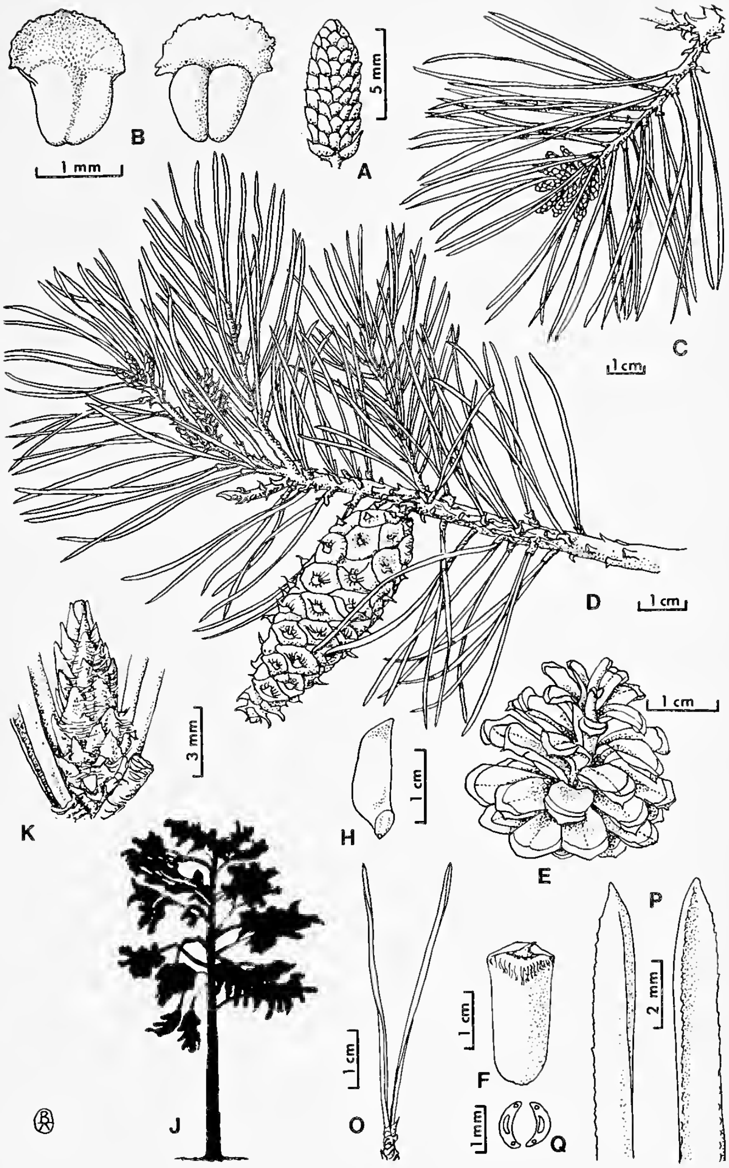
Description: monoecious; female cones solitary or in whorls of 2-3 near the apex of the current year's growth, upright, becoming horizontal or slightly pendulous following pollination, narrowly conical becoming ovoid or subglobose when mature, symmetrical, about 4 (3.5-5.5) cm long, 3.5-4.0 (-5) cm wide, red and showy prior to pollination, then red-brown, becoming dark brown weathering to gray, usually persistent for only one year after opening; **peduncles** 4-5 mm long, soon concealed by reflexed basal cone scales; **female cone scales** 60-70, oblong or slightly narrowed towards the apex, slightly incurved just below the apex, 16-19 mm long, 8-12 mm wide, **adaxial surface** concave and light brown becoming gray with age, **abaxial surface** keeled and dark brown to almost black, the upper or apical scales narrower, the ultimate pair underdeveloped and not separating, thus together cylindrical, the unopened basal scales nearly half the total number of scales and much smaller; **apophysis** broadly rhombic, 5-7 mm high, 8-12 mm wide, shiny, light brown, with a pronounced (or inconspicuous) transverse ridge or line; **umbo**

raised or depressed, unarmed, truncate, circular or transversely elliptical; **seeds** ovoid to obovoid, 3-5 mm long, 2-3 mm wide, the apex rounded, base gradually and slightly narrowed, obtuse, the sides rounded, brown to dark brown, mottled black, **wing** oblong or ovate, apex often obliquely narrowed, rounded, light brown, with dark brown striations; **male cones** 40-60 in a tight, spiral cluster covering the basal 2.0-3.5 cm of the first-year branchlet, (cones) at first erect, then horizontal and pendulous, ovoid, becoming oblong-cylindrical, 6-7 mm long and 4-5 mm wide just prior to pollen release, finally becoming nearly 15 mm long and 4 mm wide, red-brown, becoming brown, twisted after pollen dispersal, often persistent into the second year; **sterile scales** 4, ovate, about 3 mm long, 2.5 mm wide, the basal pair swollen, keeled and indurate; **male cone scales** about 150, spirally arranged, 1.7-2.0 mm long, red-brown; **lamina** flabellate or suborbicular with cordate base, about 1 mm long, 1.0-1.2 mm wide, the apex rounded, minutely laciniate or erose, red-brown with transparent margins; **microsporangia** 1.0-1.5 mm long; **scarious juvenile leaves** about 1.5 cm long and 5 mm wide at the base, long acuminate-aristate, red-brown with transparent margins, soon deciduous, leaving a hardened, persistent decurrent base, the peg projecting 1-2 mm from the branchlet; **adult leaves** almost always 2 per cluster, (7.5-) 11-15 cm long, about 1 mm wide, acute, straight, not twisted, flexible, brittle, snapping easily and cleanly when bent, hemispherical in cross section, margins minutely and obtusely toothed, green, deciduous after 2-3 years, resin canals 2, median or marginal, adaxial surface flat with 7-8 rows of stomata, abaxial surface convex with 12-15 rows of stomata; **sheath scales** about 12, light brown to red brown, increasingly transparent, becoming very tightly woven, the basal scale ovate, 3-4 mm long, keeled, indurate, second scale ovate, 3-4 mm long, third and fourth scales ovate, about 5 mm long, fifth, sixth and seventh scales ovate-oblong, about 10 mm long, eighth scale lanceolate-oblong, 14-16 mm long, ninth, tenth and eleventh scales lanceolate, 18-22 mm long, twelfth scale wholly transparent, lanceolate, about 18 mm long; **sheath** 9-12 mm long, ragged at the apex, gray-black; **buds** up to 2 cm long, ovoid, acute or obtuse, resinous, the lateral buds smaller; **bud scales** loosely imbricate, ovate, about 15 mm long, acute, red-brown; **branchlets (long shoots)** stout, 4-8 mm in diameter, roughened by the persistent, obovate or rectangular, truncate, decurrent, raised bases of the juvenile leaves, these separating into loose scales by the second year and beginning to flake off by the close of the third year, red-brown becoming dark brown or gray; **branches** stout, slightly ascending, then horizontal or sometimes pendulous; **bark** 1.5-3.0 cm thick, shallowly fissured into broad, flat ridges that peel off as thin scales, red-brown, the scales gray; **crown** broad often round- topped, with stout, spreading or ascending, sometimes pendulous branches; **trunk** 75-100 cm in diameter, straight, often devoid of branches for more than half its length; **tree** 25 (-50) m tall; **root system** spreading, with a strong taproot when young (2n = 24).

Infraspecific Variation: The growth of red pine is remarkably uniform, varying little whether in the open or in closed forest stands, and with little variation in its coarse needles, stout twigs and cone size and shape. Determination of the cultivated or wild origin of a given tree is sometimes rather difficult, since red pine can also be confused with the often-cultivated *P. nigra*, Austrian pine, which has similar leaves, cones and growth habit. Austrian pine, however, has leaves that merely fold when bent instead of snapping in two. It also has white or paler buds and lacks the red, flaking bark of the upper trunk and branches of red pine.

Importance: The light, hard, very close-grained lumber of red pine is used for general construction, crates, boxes, for pulp, and the logs for cabin and house construction. This species is planted for reforestation and sometimes for hedges, but its rapid growth makes it less suitable for the latter. Its coarse, heavy growth habit makes it an undesirable Christmas tree, and there is little use for the tree as an ornamental, although a few cultivated varieties have been developed.





5. ***Pinus virginiana*** **Miller**

Common Names: Virginia pine, Jersey pine, scrub pine, spruce pine

Type Description: Miller, Gard. Dict., ed. 8, no. 9, 1768

Synonym: *P. inops* Aiton

Origin: Native to southeastern North America

Habitats: Scattered in association with hardwoods, some trees persisting in old fields, early successional pure stands remaining in areas of sterile sand, clay or poor rocky soils. Usually competitive with overtopping species, these trees can grow on well-drained, rocky soils, but they are usually found on sand in their limited southeastern New York distribution

Habit: Small tree with long, slender horizontal or pendulous branches in widely spaced irregular whorls, forming a flat-topped or conical, irregular crown, the trunk small and devoid of branches for more than half its length even in open conditions

Pollination: April-May

Mature Cones Opening: September of the 2nd season

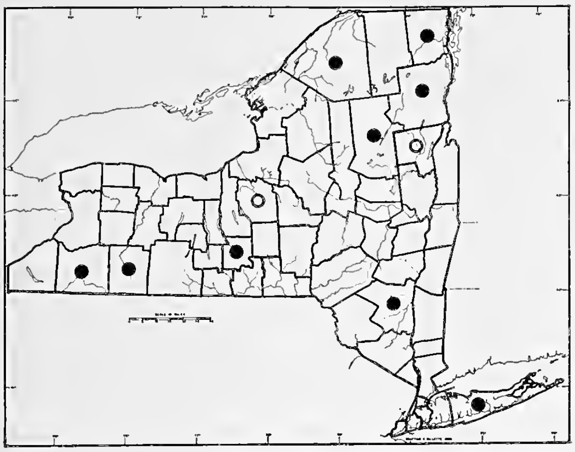
General Distribution: Southeastern New York, west to southeastern Ohio, south to northern South Carolina, northern Georgia, northern Alabama, northeastern Mississippi, western Tennessee and central Kentucky; disjunct in eastern North Carolina and southeastern Indiana

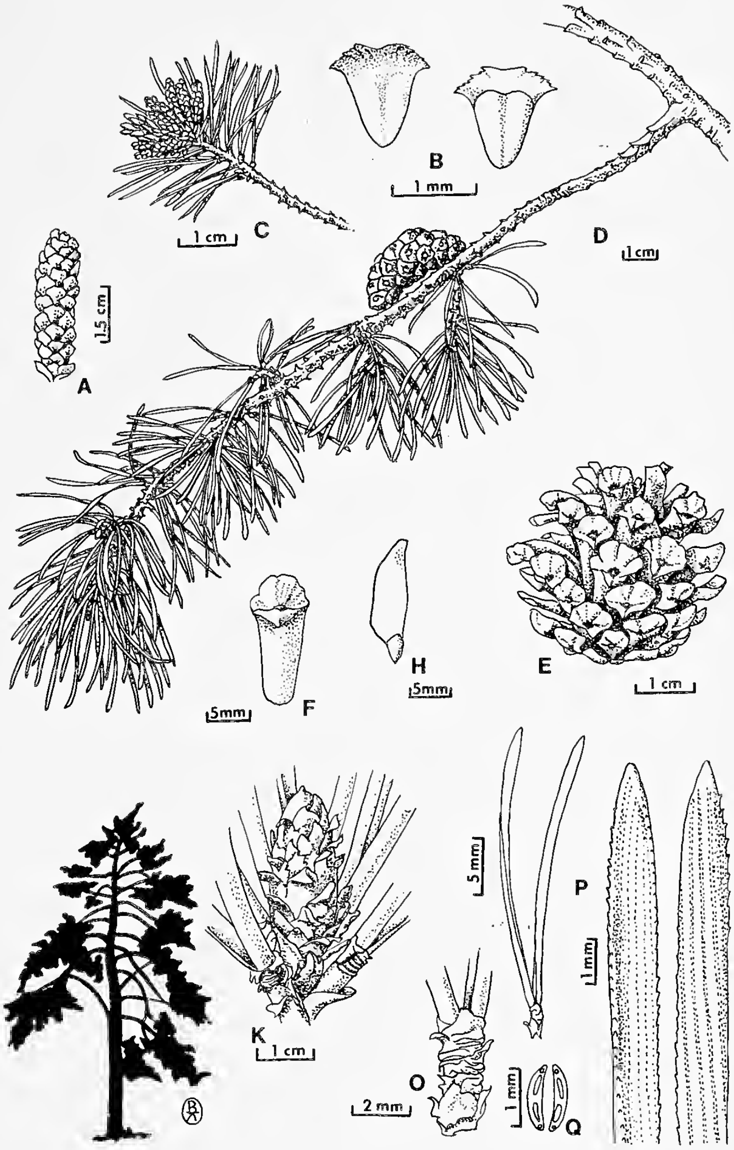
Rarity Status: This species is ranked E (endangered) under New York State law. The New York Natural Heritage Program rank is G5 S1 (globally secure, 5 or fewer extant State occurrences)

Description: monoecious; female cones solitary or 2-3 in a whorl near the middle of the first-year branchlets, horizontal, symmetrical, globose or subglobose prior to pollination, becoming ovoid, then conical, about 15 mm long, 10 mm wide prior to pollination, becoming (4-) 5 (-7) cm long 3.2-4.4 cm wide after final opening, dark red-brown or yellow-brown, then green tinged with red or pink, red-brown, finally dark brown or gray-brown, often lustrous, persistent 3-4 years after maturing; **peduncle** rough, scaly, about 5 (-10) mm long although obscured by the basal scales; **female cone scales** 100-120, the basal 1/3-1/2 never opening, oblong, 16-20 mm long, 8-12 mm wide, the basal and apical scales smaller, the uppermost pair not separating and therefore cylindric, the adaxial surface concave, pale brown beneath the wings of the seeds, turning dark brown or gray with age,

the abaxial surface broadly keeled, dark red-brown or purple-brown; **apophysis** rhombic, only slightly thickened, 4-5 mm high, 5-10 mm wide, the transverse ridge sharp and pronounced on the middle and upper scales; **umbo** armed with a sharp, straight broad-based, 2 (-4) mm long prickle that is deciduous or persistent for several years; **seeds** irregularly oblong to obovate or nearly ovoid, 4-5 mm long, 2.0-2.5 mm wide, slightly narrowed at the obtuse base, rounded at the apex and sides, pale brown, sometimes mottled black, surface rough, **wing** oblong or obovate, about 1 cm long, 5 mm wide, rounded or obtuse at the apex, obliquely pointed at the base, the brown striations inconspicuous; **male cones** crowded in clusters of 20-25 covering the basal 1 cm of the first-year branchlet, globose and 2 mm in diameter when young, becoming oblong-cylindrical, 10-13 mm long, 3-4 mm wide, red-brown, deciduous the first year, sometimes persisting into the second year; **sterile scales** 8, ovate to oblong, red-brown with transparent margins, the basal pair indurate, 2-3 mm long, the middle 4 about 4 mm long, the upper 2 about 5 mm long; **male cone scales** 60-80, about 1 mm long, 0.5-0.7 mm wide with sporangia closed; **lamina** flabellate or nearly orbicular, about 1 mm long, 1 mm wide, minutely laciniate, red-brown with transparent edges; **microsporangia** about 1 mm long; **scarious juvenile leaves** lanceolate, 3-4 mm long, deciduous the first year, each leaving a hardened, decurrent, raised, persistent leaf base; **adult leaves** almost always 2 per cluster, directed forward along branchlet in the first year, later at right angles, scattered along branchlet, usually not crowded, stout, stiff or rigid, twisting about 1.5 turns, 4-8 cm long, 1.0-1.5 mm wide, acute, incurved, minutely serrulate, the teeth closer together and spreading more toward the apex, bright green to gray-green, fragrant, persistent 2-4 years, resin canals 2, median, **adaxial surface** concave, with 12-15 rows of stomata, **abaxial surface** broadly convex, with 15-18 rows of stomata; **sheath scales** 8, ovate-oblong, the basal two about 3 mm long, slightly swollen at the base, not indurate, the third about 4 mm long, the middle 3 about 6 mm long, the 7th about 7 mm long and almost completely transparent, the 8th about 4 mm long and striated red; **sheaths** about 6 mm long the first year, 3 mm long thereafter, becoming gray or blackened; **buds** oblong, 6-12 mm long, about 2 mm wide, lateral buds often smaller, sharply acute, dark red-brown to dark brown, very resinous; **bud scales** many, imbricate, tightly appressed, ovate, about 3 mm long, acuminate, the tips eventually spreading, red-brown with transparent fimbriate margins, those of the outer scales interwoven around the bud; **branchlets (long shoots)** slender, stiff or flexible, 1-5 mm in diameter, roughened by the persistent raised decurrent bases of the juvenile scales, these forming ridges and grooves or striations that become thin, rectangular scales, flaking off in the fifth or later years, purple and glaucous the first year, becoming light brown, gray brown or dark brown; **branches** long, slender, horizontal, sometimes pendulous, in widely spaced irregular whorls; **bark** 6-12 mm thick, shallowly fissured into small, scaly scales, smooth on young trunks or branches, dark red-brown to brown; **crown** flat-topped, conical, irregular due to the long slender horizontal or pendulous branches; **trunk** rarely more than 50 (-90) cm in diameter, often devoid of branches for more than half its height, even in open conditions; **tree** 10-15 (-30) m tall, bushy; **root system** with a taproot when young, spreading ($2n = 24$).

Importance: The soft, weak, brittle wood of Virginia pine is coarse-grained and durable, and has received limited use in production of charcoal, railroad ties, rough lumber and, more recently, pulp. The seeds can be an important source of food for wildlife. This species has little value as an ornamental, although it has been used, within its broader range, for reforestation of poor lands.





6. *Pinus banksiana* Lambert

Common Name: jack pine

Type Description: Lambert, Descr. of the Genus *Pinus*, p. 7, 1803

Synonym: *Pinus divaricata* Gordon

Origin: Native to northern North America

Habitats: Dry, sandy, often poor soils, native to New York only in the northern counties, the most prominent examples being a few pure stands in the sandstone barrens of the flatrock area of Clinton County. Occasionally escaped from cultivation, and native elsewhere on sand dunes and in barrens, mixed with scrub oaks and other pine-barren vegetation, rocky ridges, less frequently in lowlands and boggy plains.

Habit: Small tree in the southern part of its range, sometimes shrubby, with slender spreading branches forming an open, broadly conical to pyramidal crown, on poor soils the crown often stunted, irregular, the branches large, spreading, with an irregular, gnarly appearance. They can grow on extremes of calcareous or acidic, fertile or sterile soils (Baldwin, 1979)

Pollination: May-June

Mature Cones Opening: September of the 2nd season (partially); often remaining closed for years, opening further after fire

General Distribution: Nova Scotia west to Yukon, south to Quebec, Ontario, northern and western Michigan, northwestern Indiana, northern Illinois, Wisconsin, eastern Minnesota, central Manitoba, northern Saskatchewan and northern Alberta; disjunct in northern parts of New Hampshire, Vermont, New York, Illinois and Minnesota

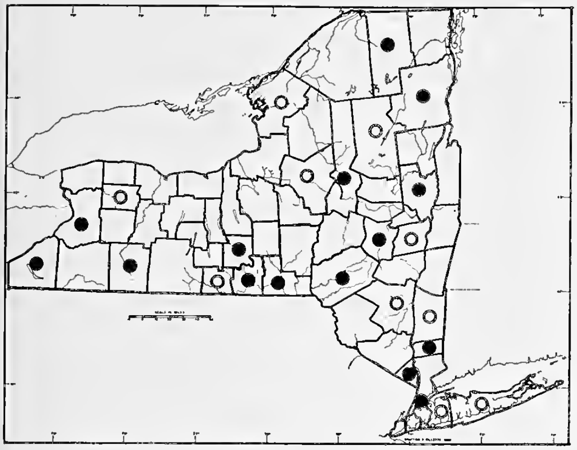
Rarity Status: This species has a State ranking of R (rare). The New York Natural Heritage Program ranks it G5,S3. This means that the species is globally secure, but populations have been reported no more than 15 times in New York State (up to 20 times with known cases of extirpation)

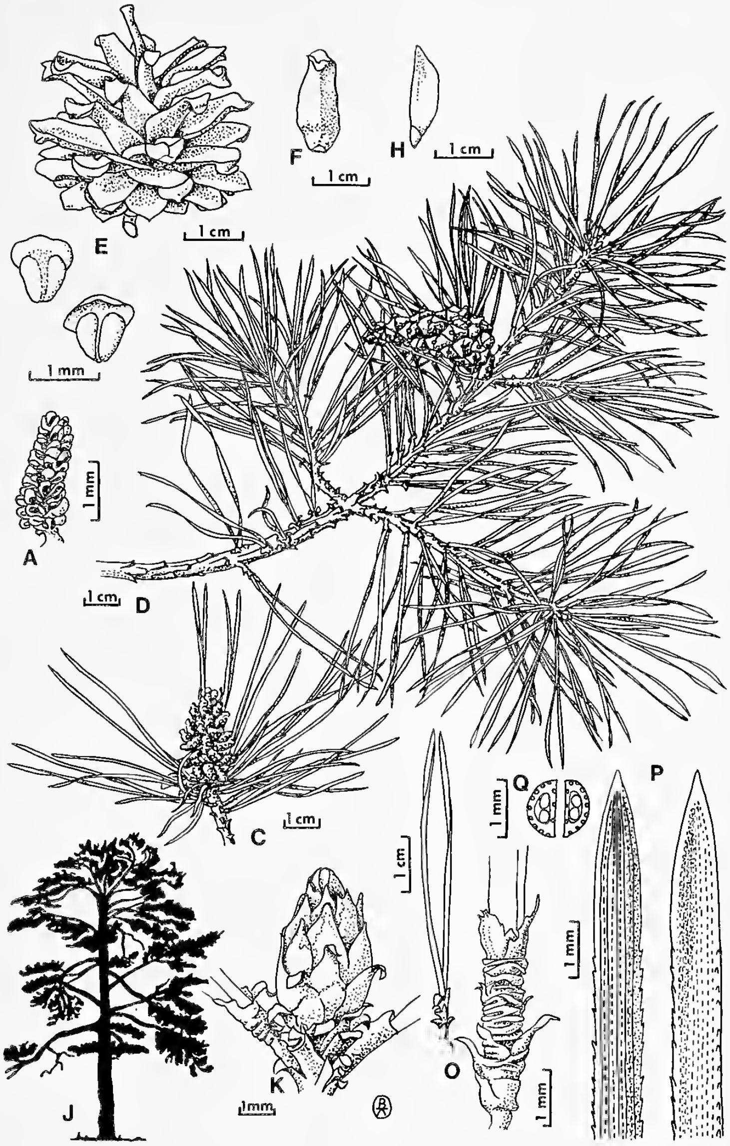
Description: **monoecious**; **female cones** solitary, or in pairs at the base of the year's growth, often present on very young trees, erect, ascending or becoming horizontal, conical or ovoid, asymmetrical, with an oblique or gibbous base, often curving into a broad, contorted C-shaped outline and becoming pressed against the branchlet, partially serotinous, 2.5-5.0 (-6) cm long, 2-3 cm

broad when open, dark purple at pollination, then dull purple or green, lustrous, becoming yellow-brown to brown when open, finally weathering dark brown or gray, often remaining at least partially closed and persisting for 25-30 or more years; **peduncle** 1-2 mm long, soon obscured by the reflexed bases of the lower cone scales; **female cone scales** about 100, the lower 10-20 remaining closed, oblong with rounded-truncate apex, 10-16 mm long, about 6 mm wide, concave, light brown to red-brown beneath the wings of the seed on the adaxial surface, broadly keeled and dark red-brown on the abaxial surface, glabrous; **apophysis** rhombic or flabellate to suborbicular, 7-8 (-11) mm in diameter, only slightly thickened or sometimes prominently thickened into a large hump or mound, the transverse line a sharp ridge or inconspicuous, yellow-brown; **umbo** unarmed; **seeds** obovate, about 3 mm long, 2 mm wide, gradually narrowing to the acute or obtuse base, roughened, pale brown to red-brown, mottled black, reticulate beneath the wing, which is oblong-elliptic, broadest in the middle, 8-10 mm long, about 4 mm wide, pale brown, the striations dense to very dense or solid at the apex; **male cones** usually 25-35 per cluster, covering the basal 1.0-1.5 cm of the first-year branchlet, straight or sometimes twisted, oblong-cylindrical, 6-8 mm long, 1.5-2.5 mm wide, red-brown, usually falling by the end of the first year; **sterile scales** 6, ovate, increasing in length from base upward or outward, 2-3 mm long; **male cone scales** 75-100, about 1.2 mm long; **lamina** semi-orbicular or flabellate, 0.8 mm long, 1.0-1.2 mm wide, the apex rounded, red-brown with transparent, minutely laciniate margins; **microsporangia** about 1 mm long, 0.5 mm wide; **scarious juvenile leaves** ovate-lanceolate, 1.5-3.0 mm long, red-brown with transparent margins, deciduous the first year, leaving a persistent, raised, decurrent base on the branchlet; **adult leaves** almost always 2 per cluster, stout, rigid, acute, straight or twisted 1/4-1/2 a turn, 2-4 cm long, 1.5-2.0 mm wide, margins serrulate and rough to the touch, bright green, persistent 2-5 years or occasionally longer, resin canals 2, median, **adaxial surface** flat or slightly concave with 7-12 rows of stomata, **abaxial surface** broadly keeled with 10-16 rows of stomata; **sheath scales** 8, the basal scale ovate, 2 mm long, indurate, the next 4 scales ovate or ovate-oblong, 3-5 mm long, the upper 3 scales obovate or oblong, 6 mm long, 2 of them nearly or completely transparent; **sheaths** 1.5-2.5 mm long in the second year, gray or black, ragged; **buds** ovoid, 3-4 mm long, the lateral buds usually smaller than the terminal ones, obtuse or with a rounded apex, pale brown, very resinous, the amber resin often completely covering and obscuring the bud scales; **bud scales** many, appressed with spreading tips, ovate-lanceolate, 2-3 mm long, acuminate; **branchlets (long shoots)** 1-5 mm in diameter, roughened by the persistent juvenile leaves or leaf bases, yellow-green or yellow-brown, changing to purple or purple-brown the first year, red-brown with striations from decurrent juvenile leaf bases the second year, gray or dark brown with thin gray flaking scales formed by the decurrent leaf bases in later years; **branches** long, horizontal, dark brown, often gnarly or twisted; **bark** thin, to 2 cm thick only on older trees, shallowly fissured into narrow ridges covered with scales, dark gray-brown, sometimes tinged with red; **crown** open and broad to conic, with slender spreading branches or stunted, irregular; **branches** large, spreading, often forming distorted, gnarly specimens; **trunk** 25 (-60) cm in diameter, straight, sometimes free of branches for 1/2–2/3 its length, but usually with lower branches and branch stumps; **tree** usually 9-12 (-25) m tall, ours often shrubby; **root system** widely spreading beyond the crown, moderately shallow, with a taproot when young (2n = 24).

Infraspecific Variation: A short-lived tree (usually less than a hundred years), jack pine does not grow straight and tall except sometimes under competition in a forest stand. Otherwise the tree is gnarled, contorted and stunted in icy and wind-blown habitats. Leaf length, branchlet and branch length are also affected by severe conditions and apparently also by acidity of the soils. Cone size remains remarkably constant, but the degree of serotiny is variable, often with a high percentage of open cones present on a tree.

Importance: Jack pine is an important early successional species. It can colonize rapidly after fire when its serotinous cones open and scatter their seeds. Fire is not required for cones to open, but fire and other disturbances do stimulate cone opening as well as producing conditions needed to reduce competition for jack pine establishment and persistence (Baldwin, 1979). Its light, soft, weak, close-grained wood is used occasionally for railway ties, posts, boxes, lath, barrel staves and pulp. With the exception of several dwarf cultivated varieties, the species is not used as an ornamental.





7. *Pinus sylvestris* L.

Common Names: Scotch pine, Scots pine, Norway pine

Type Description: Linnaeus, Species Pl. II, p. 1000, 1753

Origin: Native to northern Eurasia

Habitats: Open fields, pastures, edges of woods wet or dry soils. Escaping cultivation and planted widely throughout the State

Habit: Small to medium-sized tree with the trunk usually twisted and contorted, clear of branches in the lower half of older trees of plantations, and an irregular, open, crown with yellowish to bright orange, flaking bark highly visible and leafy branches well scattered

Pollination: May-June

Mature Cones Opening: September of the 2nd season

General Distribution: Native to Eurasia, escaping from cultivation widely in North America: from New Brunswick to Ontario, Nebraska, Iowa and Indiana, south to New Jersey, Virginia and Ohio.

Note: The number of specimens and observations of Scotch pine in the State may be misleading, due to frequency of planting. Establishment of *P. sylvestris* as an escape from cultivation is apparently infrequent.

Description: monoecious; female cones borne in pairs or whorls at the apices of the branchlets toward the end of the first season's growth, more visible at the bases of second year branchlets, pendulous or horizontal, ovoid the first year, then conical when closed following pollination, ovoid or slightly ovoid-oblong when mature and opening for the second time, symmetrical or slightly asymmetrical, 3-4 (-6) cm long, 2.5-4.0 (-5.0) cm wide, green or greenish-brown, becoming brown, persistent for several years after maturing; **peduncle** scaly or roughened, 10-12 mm long; **female cone scales** about 80, spirally arranged, oblong, concave, slightly incurved near the rounded or obtusely angled apex, 15-20 mm long, 8-10 mm wide, the apical 2-4 scales nearly terete, 2-4 mm wide, basal scales smaller and mostly not opening, the adaxial surface concave, brown to red-brown, abaxial surface broadly keeled and dark brown; **apophysis** rhombic, 7-10 mm wide at its widest point, light brown or yellow-brown, those at the base of one side of the cone often thicker, protruding, rounded, mound-like or conical; **umbo** armed intially with a prickle about 1 mm long, later truncate, emarginate or crinkled; **seeds** ovoid, 4-5 mm long, about 2.5 mm wide, rounded at the apex, acute at base, black or brown, **wing** sail-shaped or obovate, 10-16 mm long, 4-7 mm wide, obliquely angled and obtuse at the apex, wedge-shaped at base, brown, often partially striated black; **male cones** 40-70, spirally arranged in a crowded cluster

covering the basal 1.5-3.0 (-4.0) cm of first-year branchlets, oblong-cylindrical to subglobose, 4-14 mm long, 1.5-2.5 mm wide, red-brown to light brown or yellow at pollen release; **sterile scales** 4, the basal pair ovate, the upper pair oblong or spatulate, 3.0-3.5 mm long, pale brown to transparent with darker midribs; **male cone scales** 70-100, spirally arranged, crowded, 0.9-1.3 mm long, light brown; **lamina** flabellate, projecting only 0.2-0.4 mm to the side; **microsporangia** 0.8-0.9 mm long; **scarious juvenile leaves** lanceolate, long-acuminate, 7-8 mm long 1.5-2.0 mm wide at base, red to red-brown, the margins transparent, fringed, soon reflexed and coiling back, deciduous prior to expansion of the adult leaves leaving a long-persistent raised leaf base about 1 mm long and decurrent on the branchlet; **adult leaves** almost always 2 per cluster, at right angles to, or directed forward along the branchlet, coarse, stiff, mostly 4-9 cm long, 1.5-2.0 mm wide, straight or twisted 1/2 turn along the full length, minutely serrulate, light green, yellow-green or blue-green, usually persistent for 3 years; resin canals 9-11, marginal, **adaxial surface** with margins slightly recurved, the stomata in 8-12 longitudinal rows, **abaxial surface** broadly convex, with 10-18 rows of stomata; **sheath scales** 6-8, completely concealing the spur, the margins fused nearly their full length, the apex fringed, red-brown, transparent or only the margins transparent, the basal pair ovate, 2-3 mm long, the third seale about 5 mm long, the remainder 2-3 times as long as wide, 7-8 mm long; **sheaths** about 5 mm long, light gray becoming black, more tightly packed around the base of the leaves and the spur, the apex increasingly fringed and ragged with age; **buds** oblong, sometimes ovoid-oblong, 4-8 mm long before leaves begin to expand, terminal buds much larger than the lateral, resinous, red-brown, usually shaggy due to the reflexed or spreading apices of the scales, the shagginess sometimes obscured by the presence of amber or white resin deposits; **bud scales** numerous, ovate-lanceolate, about 8 mm long, 2-3 mm wide, pressed tightly together but the apex of the outer scales of several series reflexed and spreading or coiled, red-brown, margins scarious or fringed; **branchlets (long shoots)** stout, rigid on young trees or new growth, 3-6 mm in diameter, roughened by the persistent, raised juvenile leaf bases, the resulting grooves becoming gray, about 0.5 mm wide in the second year, light brown, greenish-brown or gray-green, yellow-green the first and second year, brown or gray the third year; main **branches** horizontal or slightly ascending, short and twisted on older trees, brittle, soon deciduous after dying; **bark** thin, to 3 cm thick on older trees, bright red, sometimes laced with yellow or light green, with flaking gray scales, becoming ridged and fissured at the base of older trees; **crown** full, conical and symmetrical as a young tree, irregular and open with age due to easily broken-branches, the bright red bark highly visible; **trunks** usually twisted and contorted, clear of branches in the lower half of the tree, often even in the open; **tree** to 25 m tall; **root system** with a distinct taproot when young, widely spreading (2n = 24).

Infraspecific Variation: There is great variety in leaf length and color, as well as growth habit, among trees of this species. Many cultivated varieties have been propagated. The seed source is important for Christmas tree growers in determing desirable leaf color, leaf retention and rapid and uniform growth rate. Several subspecies have been described in Europe, and clinal variation is also known in wild populations there. The leaves can be short and directed at right angles, so as to appear similar to those of *P. banksiana*, especially under stress conditions. Most trees of *P. sylvestris* planted and escaped in eastern North America are short-lived with twisted trunks and much loss of branches, giving them an aspect unlike the taller, straighter, longer-lived trees of Scotland and northern Europe. Trees of this species are distinguished from *P. banksiana* by the distinctive, bright orange, flaking bark of their upper trunks, earlier-deciduous, longer leaves with more resin canals, longer leaf sheaths and juvenile leaf bases that are longer, less-spreading and more rapidly deciduous.

Importance: Scotch pine has been important in eastern North America for reforestation, and as a Christmas tree crop. Its use in ornamental plantings has often included trimming young trees into hedges. Scotch pine is known for its rapid growth, full healthy foliage as a young plant and unusual, orange, flaking bark on the upper trunk and limbs of mature trees. In Europe its lumber and turpentine resin are important commercial products. The wood is durable but soft; most trees grown in North America are short-lived with twisted, misshapen trunks, hence this species has little value for any lumber product except pulp in this country.

2. LARIX

Common Names: larch, tamarack
Authority: Miller, Gard. Dict., abr. ed. 4, p. 744, 1754

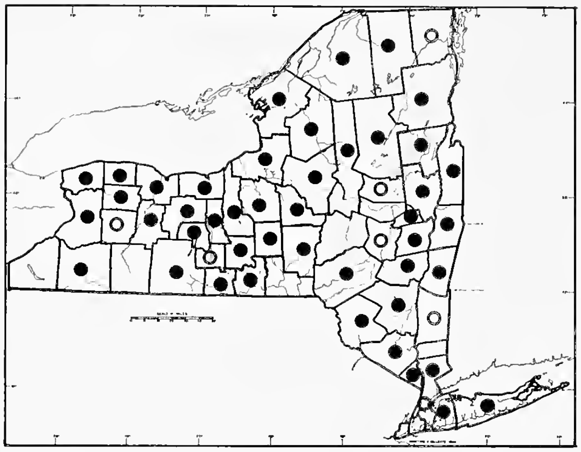
A genus of about 11 species, widely distributed in the Northern Hemisphere. Larch is one of the few conifers (along with *Glyptostrobus, Metasequoia, Taxodium, Pseudolarix*) whose leaves are deciduous the first year, and it is also one of four genera: *Larix, Cedrus, Pinus* and *Pseudolarix*, that bear their leaves in clusters at the tips of abbreviated branchlets or spurs. There are three North American species, of which *Larix occidentalis* Nutt., western larch and *L. lyallii* Parl., alpine larch, are known only from the Northwest. *Larix laricina* (Duroi) K. Koch, tamarack, the only species native to New York, has by far the broadest range of distribution, and is the larch most easily recognized. When growing in open conditions larch produces tall, straight trees with long, sweeping branches, but they may be dwarf and shrubby in alpine and arctic conditions. Logs and wood of larch are

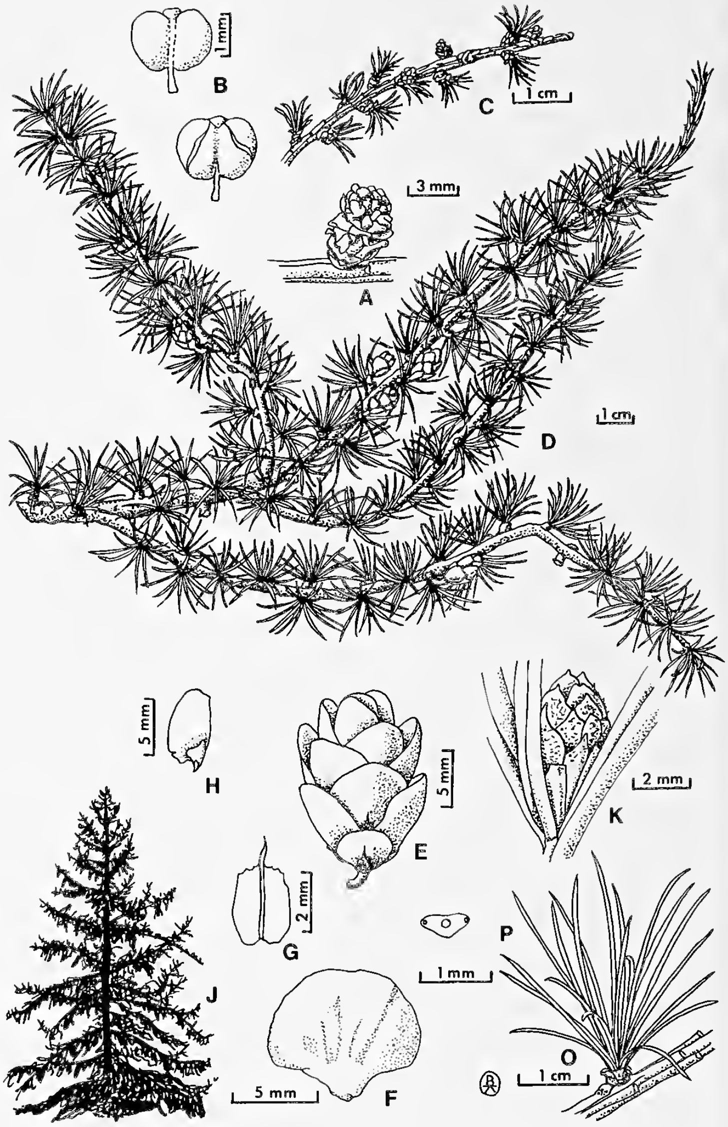
important forest products, and turpentine is manufactured from the resin. Horticultural use of larch focuses on windbreaks and its use as an ornamental tree with golden yellow leaves in the fall; however, its use is limited by the large space required by the tree's long, horizontal or often pendulous branches. The pendulous branches are also brittle and easily broken off with age, making larch a somewhat less desirable as a lawn tree. *Larix decidua* L., European larch, is the most commonly planted ornamental larch in New York State. It escapes cultivation (Cook, 1939), perhaps to a much greater extent than the number of herbarium specimens would indicate.

Description: monoecious; female cones borne terminally on third-year spurs (short-shoots), erect before pollination, then pendulous by the twisting of the peduncle, once again erect when mature, globose, subglobose or oblong, 1.2-4.0 cm long, purple when young, then green finally brown, persistent, usually only until the following year, the short shoot sometimes resuming growth, extending through the cone and elongating past the apex of the cone to become a long shoot; **peduncle** 4-15 mm long, curved, scaly; **bracts** ovate to lance-ovate or oblong, about twice as long as wide, 1.8-2.6 mm wide, light brown to yellow-green, glaucous when young, entire or sometimes erose, quickly reaching full size, thereby longer than, and exserted from the scales when the cone is young, the middle and upper bracts becoming concealed, the bracts of the basal scales broader and swollen at the base, remaining exposed, the midrib extending beyond the tip as a short awn, apex and awn green at pollination, quickly becoming brown, dark brown or purple-brown; **female cone scales** 9-50 (not including 3-4 reduced scales at the base or the greatly reduced, unopened scales at the cone apex), orbicular to flabellate, concave, thin, 7-13 mm in diameter, rose-red before pollination, becoming brown, glabrous, glaucous when young, margins entire to minutely erose or denticulate, at least toward the apex, margin of the apex sometimes emarginate (in *L. decidua*) or undulate (not in ours); **ovules** with a stigma-like development at the micropyle; **seeds** obovoid, rounded at the apex, acute at base, 1-5 mm long, 1-2 mm wide, light brown, lacking resin; **wing** obliquely ovate or sail-shaped, the apex obtuse or acute, 2.5-7.0 mm long, 1.5-4.0 mm wide, pale brown; **cotyledons** 6; **male cones** terminal on second, third and sometimes fourth-year spurs, sessile, compact, globose or nearly so, 3-6 mm in diameter; **sterile scales** about 20-60, ovate to flabellate, mostly 2-4 mm long, 1.5-2.0 mm wide, scarious, red-brown, light brown toward the thin, often rolled or crumpled, often fimbriate margins, sometimes swollen and carinate toward the base; **male cone scales** 30-60, oblong, 1-2 mm long; **lamina** barely evident, 0.1-0.3 mm long, light orange to yellow-brown; **microsporangia** opening longitudinally or obliquely, 0.7-1.3 mm long; **pollen** smooth, large, lacking wings; **leaves** dimorphic; **juvenile leaves** arranged in loose spirals along the long shoots, otherwise quite similar to adult leaves, glaucous at the base, the stomata usually in 1-2 longitudinal rows on each sided of the midrib, or sometimes only at the apex, rarely lacking on the adaxial surface and in longitudinal bands of 3-6 rows each on either side of (and equal in width to) the elevated midrib on the slightly concave abaxial surface; **adult leaves** in tight clusters at the tips of spur shoots, 12-50 per cluster, radiating outward and upward from their clustered bases, linear, often somewhat wider in the middle, 2-4 cm long, 0.9-1.6 mm wide, acute, entire, margins often so strongly recurved that the stomatal bands appear sunken into the abaxial surface, stomata conspicuous in spring, but quickly fading, resin canals 2, marginal, the leaves light green, turning a shining, bright, brilliant yellow before falling at the end of the 1st season, **adaxial surface** flattened or with a slightly raised midrib, with 1-2 (3) continuous or interrupted rows of stomata on each side of the midrib, 2-3 rows on each side at the extreme apex, **abaxial surface** with 1-4 (6) rows on each side of the elevated midrib; **buds** globose, 1-4 mm in diameter, those of the spurs reduced, the lower portion concealed by the persistent bud scales of the previous year, dark red to dark brown; **bud scales** broadly obovate or suborbicular, concave, mostly 0.5-1.3 mm long, the apex broadly rounded, shiny, dark red or red-brown, entire or fimbriate, the basal 2-4 scales of the terminal bud of the first-year branchlet ovate, smaller, acuminate, carinate, the base of the abaxial surface swollen, light yellow-brown; **branchlets** dimorphic; **long shoots** borne irregularly, often pendulous, yellow to light brown, becoming gray, dark gray or black, roughened by small (0.2 mm long) persistent projections or leaf bases of the juvenile leaves and the persistent spur shoots; **spur shoots** growing 0.5-1.0 mm per year, the persistent, recurved, dry membranous, lacerate, usually blackened bud scales forming annual rings around the spur, normally at 0.5-1.0 mm intervals, the spurs persistent for as many as 7-16 years, becoming as long as 1 cm; **branches** slender and ascending in the upper crown, often very long, the lower branches often horizontal or pendulous, persistent to the ground in open conditions covering only about half the trunk in closed forest stands; **bark** thin, smooth on young trees, 1-2 cm thick on older trees, furrowed and flaking off in small plates; **crown** regular and conical in open conditions, irregular with age, the leading shoots pendulous; **trunk** 50-150 cm in diameter; **tree** 10-50 meters tall, smaller and shrubby in more northern climates; **root system** shallow, spreading.

KEY TO SPECIES

1. Female cones 2.0 cm long or less, glabrous; branchlets orange-brown to red-brown .... 1. *L. laricina*
1. Female cones 2.5 cm long or more, puberulent; branchlets yellow or yellow-brown .... 2. *L. decidua*





1. *Larix laricina* **(Duroi) K. Koch**

Common Names: larch, tamarack, hackmatack. eastern, black, red, Canadian or Alaskan larch, hackimack

Type Description: Duroi, Obs. Botanicae, p. 69, 1771

Synonyms: *L. americana* Michx., *Pinus laricina* Duroi

Origin: Native primarily to the taiga zone of North America

Habitats: Frequently in moist locations, in swamps, along lake shores and river banks, particularly in southern parts of its range, but also on well-drained hillsides and mountain peaks farther north. Often found at high elevations in New York State, but confined to cold swamps or sphagnum bogs and fens at middle and lower elevations

Habit: A small to medium-sized tree with a narrow, regularly conical crown in open conditions, and erect to pendulous leading shoot (in open conditions), often becoming contorted and broader with sweeping branches persistent to the base; commonly small and shrubby in more northern climates and dwarfed at treeline

Pollination: April-May

Mature Cones Opening: September-November of the 1st season

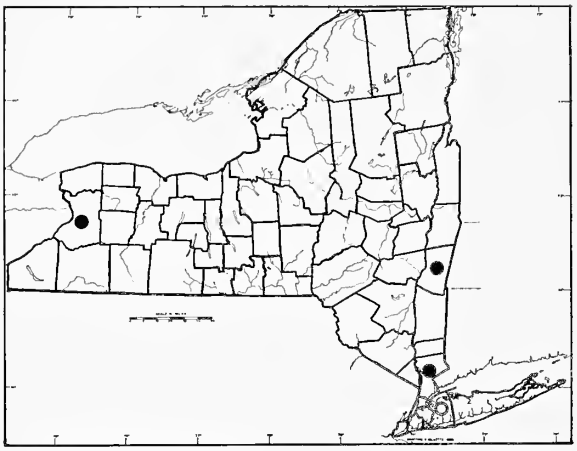
General Distribution: Newfoundland west to Alaska, south to northern New Jersey, northern Pennsylvania, northern Ohio, northern Indiana, northeastern Illinois, Wisconsin, eastern Minnesota, Manitoba, Saskatchewan and northern Alberta; disjunct in southwestern Pennsylvania, western Maryland, northern West Virginia and western Ohio

Description: monoecious; female cones globose or subglobose to oblong, 1.2-2.0 cm long, and nearly as wide; **peduncle** 4-5 mm long, scaly; **bracts** ovate to lance-ovate or oblong, about 4 mm long, 2.0-2.5 mm wide, light brown to yellow-green, glaucous when young, entire or sometimes erose, the awn about 1 mm long; **female cone scales** 9-12, not including 3-4 reduced scales at the base, or the greatly reduced, unopened scales at the apex, orbicular or nearly so, concave, thin, 7-9 mm in diameter, glabrous, the margins entire to minutely erose or denticulate, at least towards the apex; **seeds** obovoid, rounded at the apex, acute at the base 1.2-2.2 (2.5) mm long, 1.0-1.2 (1.5) mm wide, light brown, lacking resin, the **wing** obliquely ovate, apex obtuse or

acute, (2.5) 3.3-4.5 (5.0) mm long, (1-) 1.5-2.8 mm wide, pale brown; **male cones** globose, 3-4 mm in diameter; **sterile scales** about 24, ovate to flabellate, about 2 mm long, 1.5 mm wide, margins thin, rolled and often crumpled; **male cone scales** about 30, oblong, 1.0-1.5 mm long; **lamina** barely evident, (1-) 1.2-1.4 mm long; **microsporangia** opening longitudinally or obliquely, about 0.7 mm long; **juvenile leaves** with stomata usually in 1 or 2 longitudinal rows on each side of the midrib, or sometimes only at the apex, rarely lacking on the adaxial surface, with longitudinal bands of 3-6 rows of stomata on each side of elevated midrib on the slightly concave abaxial surface; **adult leaves** 25-35 per cluster on first- and second-year branchlets, 30-40 per cluster on older branchlets, often somewhat wider near the middle, (1.7) 2.2-2.7 (3.3) cm long, 0.8 mm wide, acute, light green, turning to a shining, brilliant yellow before falling after the 1st season, 1 row, and often an interrupted second longitudinal row, of stomata on each side of the slightly raised midrib, 2-3 rows per side at the extreme apex, **abaxial surface** with 2-3 stomatal rows on each side of the strongly elevated midrib; **buds** globose, 2-4 mm in diameter, those of the spurs reduced and the lower portion concealed by persistent bud scales of the previous year, dark red to dark brown; **bud scales** broadly obovate or suborbicular, concave, less than 1 mm long, the apex broadly rounded, shining, dark red or red-brown, entire or minutely ciliate; **long shoots** often pendulous, yellow-brown or light orange-brown the 1st year, becoming dull brown then gray, dark gray or black; **spurs** growing less than 0.5 mm per year, bud scales forming annual rings around the spur, normally at 0.5 mm intervals, spurs persisting for as many as 7-16 years, becoming as long as 1 cm; **branches** slender and ascending in the upper crown, very long, arching upward at the tips, horizontal or pendulous lower on the tree; **bark** smooth on young trees or on upper branches becoming appressed and thinly scaled, the small, rounded scales flaking off, light orange-brown becoming red-brown, shallowly furrowed, thin, 1-2 cm thick on older trunks; **crown** narrow, regularly conical in open conditions, often ice-damaged at the apex, becoming contorted and irregular with age, lower branchlet tips pendulous, brittle with age; **trunk** 50-65 (-100) cm in diameter; **tree** 10-20 (-35) m tall, smaller and shrubby in more northern climates, the branches persistent to ground level in open conditions, covering only about half the trunk in dense, forest stands; **root system** shallow, wide-spreading, moderately wind-firm ($2n = 24$).

Infraspecific Variation: *Larix laricina* is known to hybridize with *L. decidua* producing trees with cones that have 20-30 pubescent scales. This hybrid species, *L.* × *pendula* Salisbury, was named from trees in England in 1808, but is also known from northeastern United States, including New York. *Larix laricina* var. *incurva* Peck was named from trees in Sullivan County, New York.

Importance: The heavy, hard, very strong wood of larch is durable, somewhat coarse-grained and fire-resistent, making it an important source of telephone poles, railroad ties and fence posts. The wood has also been used in commercial shipbuilding and for turpentine extraction, and the bark has been a source of food and medicines. The roots were used by Native Americans as thread for sewing strips of birch bark to their canoe frames, while early pioneers used the roots for framing their canoes. Use of trees and shrubs of this species as ornamentals is limited, because of the large space required by healthy specimens with long, drooping lower branches. The ability of larch to grow in wet areas occasionally makes it useful for specific landscaping needs.



2. *Larix decidua* Miller

Common Name: European larch

Type Description: Miller, Gard. Dict., ed. 8, no. 1, 1768

Synonym: *L. europaea* DC.

Origin: Native to Europe and Siberia

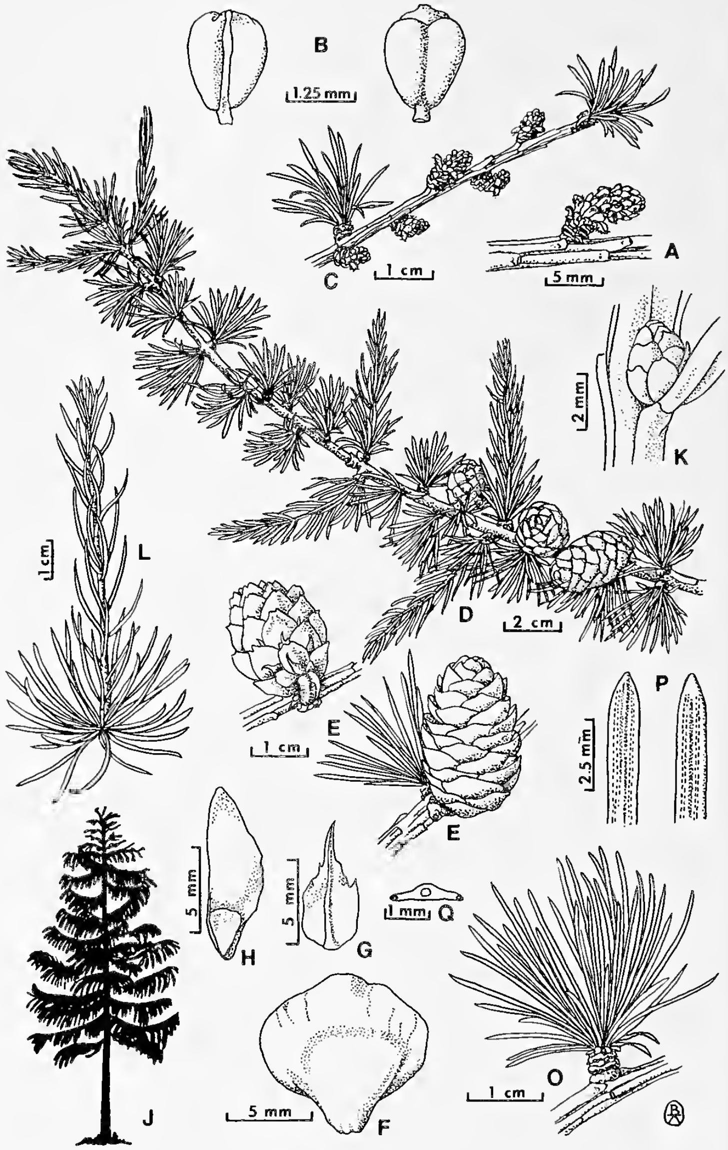
Habitat: Open or closed woods, escaping rarely in cultivated stands and nearby areas

Habit: Tall tree with spreading branches, clear of branches in the lower half or the tree under forest conditions

Pollination: May

Mature Cones Opening: September of the 1st season

General Distribution: Europe east to Siberia; escaping cultivation in eastern North America including New York State



Description: monoecious; female cones 2.7-3.4 cm long, (1.7) 2.1-2.4 cm wide; **peduncles** (5) 6-8 (10) mm long; **bracts** oblong or lance-ovate, 7-9 mm long, 1.8-2.6 mm wide, the awn 2-3 mm long, decurrent at the base, dark red-brown at the base, lighter near the apex; **female cone scales** about 40-70, not including reduced scales at the base and apex, orbicular or orbicular-flabellate, thin, (8-) 10 (-13) mm in diameter, the apex sometimes slightly emarginate, puberulent on both surfaces, margins entire; **seeds** obovoid, about 4 mm long, 2 mm wide; **wing** sail-shaped, the apex obtuse, 5-7 mm long, about 4 mm wide, pale brown; **male cones** usually globose, sometimes slightly longer than wide, 4-6 mm in diameter; **sterile scales** 50 or more, ovate, 3-4 mm long, about 2 mm wide, the apex often tightly rolled back, the margins fimbriate; **male cone scales** 50-65, 1.6-2.0 mm long; **lamina** about 0.3 mm long, red-brown; **microsporangia** opening longitudinally, 1.2-1.4 mm long; **juvenile leaves** 1.8-2.3 cm long, more than 1 mm wide, the stomata in 1 or 2 longitudinal rows on each side of the midrib (toward the base), 2 (3) rows near the apex of the flat, adaxial surface, and (1) 2-3 (4) rows on each side of the slightly raised midrib on the abaxial surface; **adult leaves** usually 30-50 per cluster, 1.6-2.9 (3.3) cm long, 1.0-1.3 cm wide, bright green, becoming yellow before falling in the 1st season, **adaxial surface** flattened, with 1-2 longitudinal rows of stomata on each side of the midrib near the base, becoming 2-3 rows near the leaf apex, **abaxial surface** with 1-4 rows of stomata on each side of the elevated midrib; **buds** globose, 1-2 mm in diameter; **bud scales** nearly orbicular, concave, 0.5-1.3 mm in diameter, entire to slightly erose; **branchlets (long shoots)** often pendulous, glaucous the first year, yellow or light yellow-brown the first and second years, becoming yellow-brown or red-brown with gray stripes or furrows by the fourth year, later brown to black; **spurs** with annual rings about 0.8 mm thick, persisting up to 10 years or more; **branches** slender, stiff and ascending in the upper crown, long, horizontal, often pendulous lower on the tree; **bark** thin, 1-2 cm thick, smooth on young trees, fissured on older trunks, shedding as

small rounded plates, brown to dark gray; **crown** conical in both open and forested conditions, becoming irregular with age; **trunk** to 1.5 m in diameter; **tree** to 20 (-35) m tall, devoid of branches in the lower half in forest conditions; **root system** shallow (2n = 24).

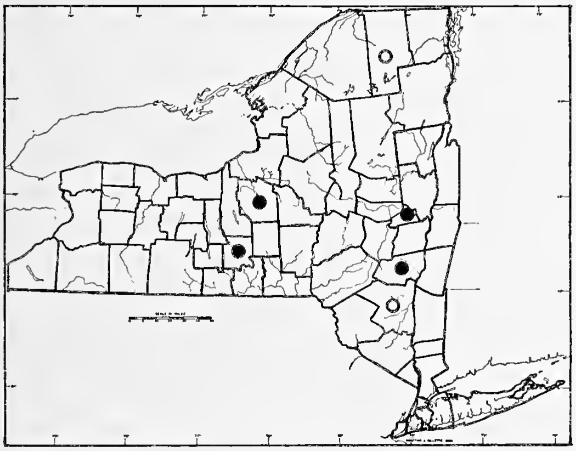
Importance; Once abundantly planted for reforestation purposes because of its rapid, straight growth capabilities and strong, durable wood, European larch is now only occasionally planted as an ornamental.

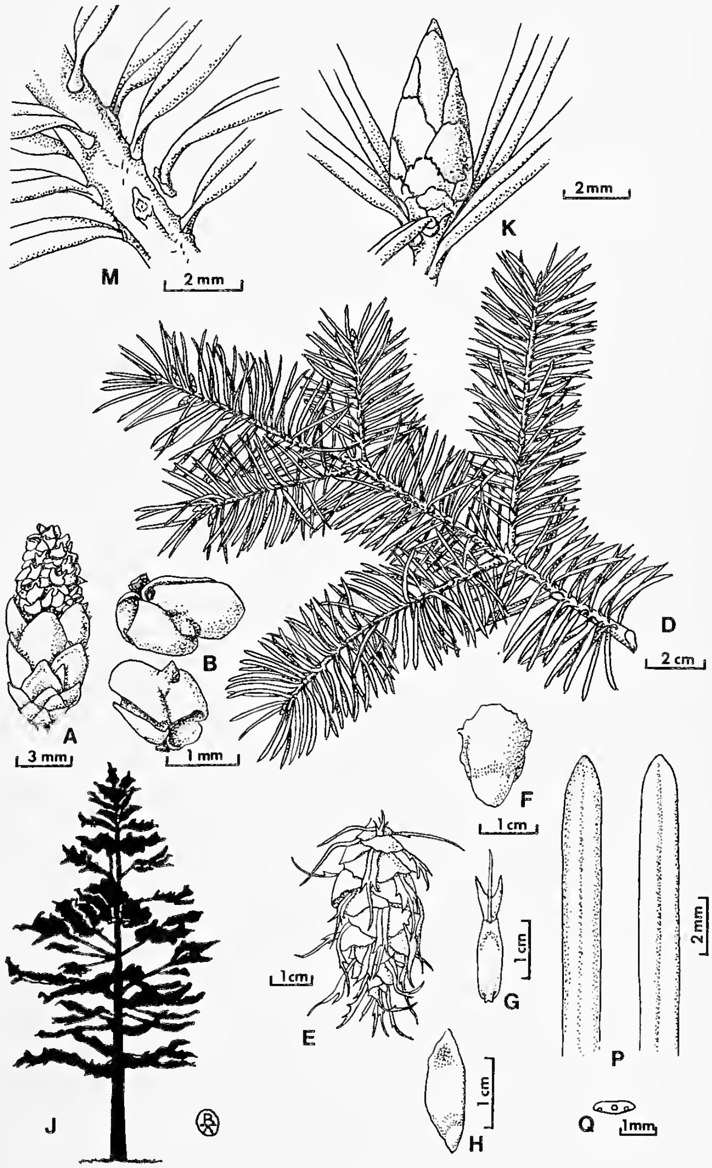
3. PSEUDOTSUGA

Common Names: Douglas-fir, Doug-fir, hangcone-fir

Authority: Carrière, Traité, Gén. Conif., ed. 2, p. 256, 1867

Pseudotsuga is a genus of about 5 species of western North America and eastern Asia. As many as 11 other species have been named, mostly in China and Mexico, but these are taxonomically questionable. *Pseudotsuga macrocarpa* (Vasey) Mayr is a southern Californian endemic. The Douglas-fir, *P. menziesii* (Mirb.) Franco, a native of the Rocky Mountains and other ranges in western North America, has the broadest distribution range. This species is immensely important for its timber and in the Christmas tree trade.





1. *Pseudotsuga menziesii* (Mirb.) Franco

Common Names: Douglas-fir, Doug-fir, Oregon-pine, Douglas-spruce, Douglas-yew

Type Description: Mirbel, Mem. Mus. Hist. Nat., vol. 13, pp. 63, 70, 1825

Synonyms: *Abies menziesii* Mirb., *A. douglasii* Lindl., *Picea douglasii* Link, *Pinus douglasii* (Lindl.) Link, *P. taxifolia* Lambert, *Pseudotsuga douglasii* (Lindl.) Carrière, *P. lindleyana* Carrière, *P. taxifolia* (Lambert) Britt., *P. mucronata* Sudw.

Origin: Native to western North America

Habitats: In its native range, from sea level to about 3500 meters mostly in mixed conifer and mixed evergreen forests on deep, loamy well-drained soils, moist or drier exposed, rocky slopes, in the open or tolerating shade. Reproducing in New York State in a few instances where it establishes near plantations or large isolated trees

Habit: Large, straight-trunked tree with a conical, regular crown and horizontal branches

Pollination: April-June

Mature Cones Opening: September-October of the 1st season

General Distribution: The Rocky Mountains from southern Alberta north to central British Columbia, south to central California on the West Coast, and in the interior to New Mexico and west Texas, with outliers in Mexico as far south as Oaxaca. The tree occasionally escapes cultivation elsewhere, including New York State

Rarity: At this time, documented instances of naturalization after escape from cultivation in New York are rare. Inclusion of the species in this treatment as anything more than a waif is debatable; however, with increasing age of stands already planted in northeastern North America, and rising use in cultivation, successful reproduction, dispersal and establishment of this species should increase.

Description: monoecious; female cones pollinated, fertilized and maturing in the same year, borne scattered along the 2nd-year branchlets, erect or horizontal, rapidly becoming pendulous, oblong-cylindric, somewhat narrowed at the apex, 5-8 (10) cm long, 2.7-3.3 cm wide, green when young, becoming brown, resinous, falling as a unit by spring of the following year; **peduncles** 7-11 mm long, initially erect or straight, soon curving down, covered with early-deciduous leaves; **bracts** exserted half their lengths, sometimes reflexed, obscurely spatulate to oblanceolate, 17-25 mm long, including the awn, 4-5 mm wide, papery, green when young, becoming brown, glabrous, upper margins irregularly serrate or erose, the apex bearing a central awn with a tooth on each side, the awn acicular, 7-12 mm long, half as long as the exposed portion of the bract, the 2 side cusps deltoid, 2.0-3.3 mm long, up to 2-3 mm wide, often weakly to strongly reflexed; **female cone scales** 35-40, orbicular or flabellate, concave, thin, 11-15 mm long, 13-22 mm wide, green with bright red apical margins, becoming brown, densely puberulent on the abaxial surface when young, slightly puberulent at the apex and on exposed parts of the adaxial surface; **male cones** borne laterally in loose clusters of 5-15 near the tips of the branchlets; cones oblong-cylindric, 8-13 mm long, 2-3 mm wide, light orange-red or red-brown, often persistent into the next year; **peduncle** minute, completely concealed by sterile scales; **sterile scales** about 50, ovate-flabelliform, 2-5 mm long, 2-4 mm wide, the inner larger than the outer or basal ones, membranous, clear to light brown, glabrous, the inner scales ciliate-margined; **male cone scales** about 1.2 mm long, 1 mm wide, pale brown or yellow, glabrous; **lamina** barely evident, about 0.2 mm long; **microsporangia** dehiscing longitudinally, 0.7-0.9 mm long; **pollen** lacking wings; **leaves** solitary, spirally arranged, flattened, the bases twisted so that the leaves lie predominantly in one plane, leaves narrowed at the base, attached to a slightly swollen projection of the branchlet, part of the branchlet bark often pulling away on detachment, the leaf (1.7) 2.0-2.4 (3.0) cm long, 0.9-1.3 mm wide, bright green, sometimes blue-green, the narrowed base yellow-brown or yellow, glaucous when young, persistent, usually for 5-7 years or sometimes longer, **adaxial surface** lacking stomata, darker green, **abaxial surface** pale green, with 2 resin canals near the margins and 4-6 interrupted, longitudinal rows of stomata on each side of the elevated midrib; **buds** conical or cylindric-conical, usually more than 2.5 times as long as wide, (5) 7-8 (9) mm long, 1.8-2.8 mm wide, acute, red-brown, glabrous, non-resinous; **bud scales** numerous, obovate or oblanceolate, 6-10 mm long, 4-5 mm wide, membranous, red-brown with hyaline margins, ciliate on the upper margins of the inner scales; **branchlets** horizontal, then pendulous, lustrous orange-brown the 1st year, bright red-brown the 2nd year, brown or gray thereafter, pubescent, becoming glabrous by the 4th year, older branchlets slightly roughened by the minute, swollen points of detachment of fallen leaves; **branches** horizontal, slender, often crowded; **bark** smooth, thin, often shiny, gray on young trees, becoming 20-30 cm thick and corky, with deep, rough furrows on older trees, orange-brown to dark brown; **crown** often narrow, conical to cylindrical; **trunk** straight, commonly reaching 1-2 (-3) meters in diameter (historically up to 5 meters), devoid of living branches in the lower 2/3 of the tree in crowded forest eonditions; **trees** up to 70 (-90) meters tall; **root system** strong, well-developed laterally and wide-spreading (2n = 24).

Infraspecific Variation: Prominent among the characters that show variation are: leaf color and length, cone size, bark color, bract thickness and texture, and the degree of braet recurvature. Rocky Mountain populations are *P. menziesii* var. *glauca* (Beissn.) Franco, differing from the typical west-coast variety in having blue-green, shorter leaves, smaller cones, strongly reflexed bracts, ascending branches and a slower-growing, more compact or dense growth habit. Several varieties have also been described from Mexico. Several cultivars have been propagated for ornamental use, including a few dwarf variants. Christmas tree growers select for blue or glaucous foliage and late spring new-growth, to avoid frost damage.

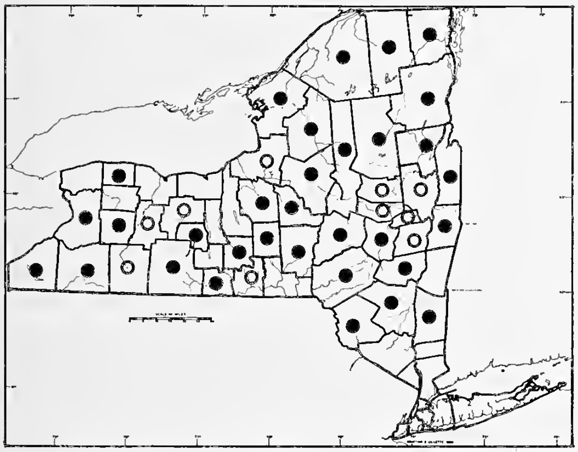
Importance: Douglas-fir is currently the most important lumber tree of North Ameriea. It is used mainly for construction purposes, prized for the huge girths attained by trunks that yield a largely knot-free wood. The wood is also strong, relatively light, straight-grained and durable. It does not warp or twist easily, and it hold nails well. This species is currently planted in western states on a large scale for timber, but also widely grown in eastern North America as a Christmas tree crop, as well as for ornament.

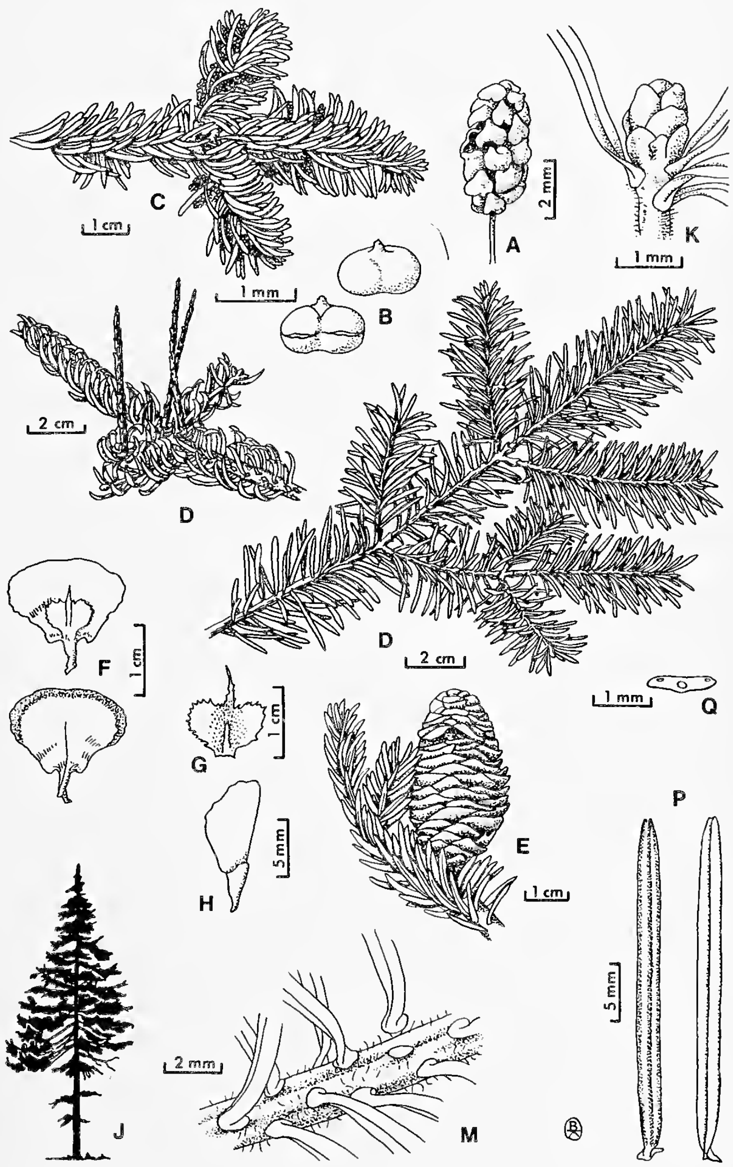
4. ABIES

Common Name: fir

Authority: Miller, Gard. Dict., abr. ed. 4, p. 16, 1754

Abies is a genus of about 40 species of tall, straight, symmetrically-branched forest trees of northern boreal and high altitude forests in the Northern Hemisphere. It is a taxonomically difficult genus, since firs appear to hybridize freely in cultivation, and several natural hybrids have been described from the wild. The genus is represented in eastern North America by 1-3 species, depending upon interpretation. Distinctive generic features of *Abies* are the erect female cones whose scales are deciduous, leaving naked cone axes on the branches, well-developed bracts inserted or exserted from between the scales, solitary leaves that are hypostomatic or amphistomatic, and whorls of branches at regular intervals on straight, tall and narrow, often spire-like trees. Logged for lumber and pulp, firs are also economically important as Christmas trees and for their resin. *Abies fraseri* (Pursh) Poir., Fraser fir, is a rare escape from cultivation in New York. A native of the southern Appalachians, it is closely related to our native *A. balsamea* (L.) Mill. It is distinguished from *A. balsamea* by exserted female cone bracts and more rows of stomata on the abaxial surfaces of the leaves. *Abies homolepis* Sieb. & Zucc. (native to Japan) and *A. magnifica* A. Murr., red fir (one of 12 species of western North America and five in the western United States), have escaped cultivation at single separate sites in New York State. *Abies magnifica* is easily distinguished from firs of eastern United States by its very large cones and gray or blue-gray, amphistomatic leaves. *Abies concolor* (Gord. & Glend.) Lindl. ex Hildeb., another western fir with blue-gray leaves is increasingly cultivated as a Christmas tree and ornamental in eastern North America.





1. *Abies balsamea* (L.) Miller

Common Names: balsam fir, balsam, fir-balsam, fir-pine, blister-pine, blisters, single-spruce, balm-of-Gilead, balm-of-Gilead fir, Canada balsam, eastern fir

Type Description: Linnaeus, Species Pl. II, p. 1002, 1753

Synonym: *Pinus balsamea* L.

Origin: Native to northeastern North America

Habitats: Boreal and montane forest tree in New York State, at high elevations in poorly drained soils of low, swampy ground and at the edges of bogs in the Adirondack and Catskill Mountains, thriving in cold swamps and bog borders (rarely, on well-drained north-facing hillsides) at lower elevations and non-mountainous parts of the State. Usually associated with red and black spruce, tamarack, and hemlock, in natural stands, also escaping cultiva-

tion in some wet or boggy areas and on moist northern hillsides

Habit: Medium-sized tree with a slender, symmetrical crown, becoming broader with age, or dwarfed at high elevations approaching timberline

Pollination: May-June

Mature Cones Opening: August-September of the 1st season, seed dispersal: September-November

General Distribution: Newfoundland west to north-central Alberta, south to northeastern Connecticut, northern Pennsylvania, northern Michigan, northern Wisconsin and northeastern Minnesota; disjunct in southwestern Wisconsin, northeastern Iowa, southeastern Minnesota and the Appalachian Mountains of Pennsylvania, West Virginia and Virginia

Description: monoecious; female cones solitary, borne on the upper (adaxial) surface of the branchlet of the previous year's growth, sessile, oblong-cylindrical, (3) 4-6 cm long, 2-3 cm wide, purple to dark purple or violet when young, becoming green or brown at maturity, usually covered or splotched with resin, scales deciduous the first year, leaving a slender, tapered, dark brown cone axis about 1 mm in diameter at the apex and 3 mm in diameter at the base, sometimes with a few small scales remaining at the base, frequently with a few undeveloped scales and seeds still attached at the apex; **bracts** longer than the scale and exserted when young, shorter than and enclosed by the subtending scale at maturity (remaining exserted in var. *phanerolepis*), flabellate-cuneate, spatulate or pandurate-spatulate, about 10 mm long, 5 mm wide, abruptly narrowed at the base and flattened against the cone scale above, pale brown, darker brown at base, the margins erose, midrib extending beyond the emarginate apex into a slender, acuminate awn 1-2 mm long; **female cone scales** deciduous, fan-shaped or flabellate, abruptly narrowed at the cuneate base, much shorter than the bract when young, usually longer than the bract when mature, about 1.5 cm long, 1.0-1.5 cm wide, purple when young, becoming brown with age, entire, the upper margins membraneous, the exposed apex slightly upturned, often slightly erose, becoming pale green and pubescent; **seeds** wedge-shaped, 3-5 mm long, brown, lustrous, resinous, the **wing** wedge-shaped or obovate, obliquely cuneate at the base, about 9 mm long, 6 mm wide, light brown; **cotyledons** mostly 4 (5); **male cones** crowded in axils of leaves, principally along the sides and abaxial surface of the previous year's branchlets, pendulous, oblong-cylindrical, 6-10 mm long, 1.5-3.0 mm wide, yellow, deeply tinged red-purple; **sterile scales** 14-20, ovate, dark brown, scarious, the upper few falling with the cone, the remainder hardening and remaining on the branchlet for many years; **peduncles** 2-3 mm long, naked, partially concealed by the sterile scales at the base; **male cone scales** 50-70, spirally arranged, cordate, appearing peltate after opening of the microsporangia, about 1 mm long; **lamina** merely a minute mucro or beak at the apex of the stalk between the sporangia, about 0.1 mm long; **microsporangia** nearly as long as the stalk, opening by a transverse slit near the middle; **pollen** with two bladders (wings); **leaves** all similar on the same branchlet but consistently different on fertile or upper branchlets, spirally arranged, sessile, linear, entire, revolute, the base slightly broadened into a disk that leaves a circular scar when detached, aromatic, with a longitudinal resin canal on each side between the midrib and margin, persisting 5-7 (-10) years; **leaves** (on **upper and fertile branches**) directed forward and toward the upper side of the branchlet by a curving of the leaf bases, somewhat angular due to the thickened, elevated midrib on the adaxial surface, shorter than those on lower or sterile branchlets, stout, stiff, rigid, about 1 cm long, 1.5 mm wide, nearly one third as thick as wide, acute to acuminate or sometimes obtuse, often pungent, sharply curved upward at the apex, gray to gray-green, the stomata on the adaxial surface in longitudinal rows of 4-6 near the base to 8-10 near the apex, the abaxial surface with 8-10 rows of stomata on each side of the raised midrib; **leaves** (on **sterile branchlets**) spreading horizontally by twisting of the leaf bases, pectinate, flat, 1.5-2.5 cm long, about 2 mm wide, emarginate or obtuse, **adaxial surface** dark green, lustrous, usually with 1-2 (-3) short rows of stomata near the apex, the midrib a groove, **abaxial surface** pale green, with 2 longitudinal white or pale bands of stomata, each consisting of (4-) 6-8 (-10) rows of stomata, the stomatal bands losing their whiteness with age, the midrib slightly raised and separating the stomatal bands; **buds** ovoid to globose, obtuse, about 3 mm long, orange-green, very resinous; **bud scales** many, in 5-6 or more ranks, about 1 mm long, ovate or obovate, sometimes attenuate, red-brown to orange-green tinged with purple, lustrous, the margins membraneous and short-fimbriate, the outer scales hardening and persisting for many years; **branchlets** opposite, rarely irregular, slender, 1-4 mm in diameter, light gray, gray-green or yellow-green the 1st year, becoming gray-brown, brown or blackend, smooth, the circular leaf scars not raised, pubescent, the short gray hairs becoming blackened through the accumulation of dust particles and fewer in number with age; **branches** usually (4) 5 (-7) in regular whorls, the lower branches dying and soon falling in closed forest conditions; **bark** of young trees smooth, thin, tight, gray with prominently raised areas or blisters containing resin, becoming 1.5 (-3.0) cm thick on older trees, separating into small irregular flakes, red-brown, gray-brown or dark gray; **crown** conical, symmetrical, slender, becoming broader when old, irregular, dwarfed or flagging under climatic stress near treeline; **trunk** to 50 (-100) cm in diameter, **tree** short-lived (often less than 100 years), 10-29 m tall, only 1-2 m tall at high elevations approaching timberline; **root system** shallow to moderately deep, depending on soils, wide-spreading (2n =24).

Infraspecific Variation: *Abies balsamea* var. *phanerolepis* Fern. is apparently found in a few locations scattered through nearly the entire eastern range of balsam fir. Trees corresponding to this taxon have sometimes been considered natural hybrids of *A. balsamea*

and *A. fraseri* of the southern Appalachians. Current indications are that var. *phanerolepis* differentiated in isolation since the Pleistocene, rather than resulting from hybridization during post-Pleistocene range expansions from separate refugia (Jacobs *et al.*, 1984; Zavarin & Snajberk, 1972). The most distinctive feature of var. *phanerolepis* is presence of slightly-reflexed, exserted bracts in the mature cone, while its other characteristics fit within the range of variation of typical *A. balsamea*. Cones of var. *phanerolepis* are also generally on the shorter end of the range of variation for var. *balsamea*. The bracts may be barely visible or long-protruding as in *A. fraseri* and slightly reflexed. Characters, such as a greater number of stomatal rows on the leaves and redder hairs on the twigs of *A. fraseri* are variable, and do not adequately distinguish the two species. The adaxial surfaces of leaves of *A. balsamea* may have no stomata, stomata that occur only near the tips, or a row or two extending nearly half the length of the leaf. *Abies balsamea* f. *hudsonia* (Bosc ex Jacques) Fern. & Weath. was named on the basis of the prostrate habit and shorter, broader leaves of plants that are found at treeline or other harsh, wind-swept high-elevation sites.

KEY TO VARIETIES

1. Bracts of the female cone not exserted beyond the scales ....1a. *A. balsamea* var. *balsamea*
1. Bracts of the female cone exserted...1b. *A. balsamea* var. *phanerolepis*

1a. *Abies balsamea* var. *balsamea*

Common Name: balsam fir

Habitats: Primarily high elevations in the Adirondack and Catskill Mountains, swampy areas and edges of bogs; rarely on well-drained north-facing slopes at lower elevations

Habit: Tree with symmetrical crown, except near timberline when the Krummholz (low shrubby, sometimes prostrate) form is evident

1b. *Abies balsamea* var. *phanerolepis* Fern.

Common Names: bracted balsam fir, hybrid fir, Canaan fir, bracted fir

Habitats: As in *A. balsamea* var. *balsamea*, but occurring only very rarely in New York and the Northeast

Habit: A tall tree with a symmetrical crown

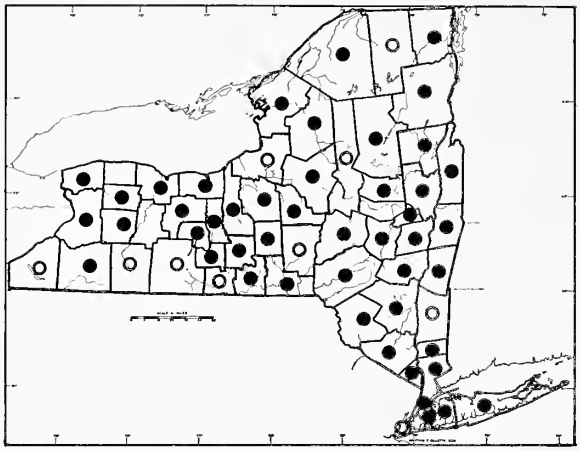
Importance: Balsam oil gathered from "blisters" on tree trunks has been a valuable medicinal remedy for a great variety of ailments by Native American and early European setters. A turpentine is made from the oil that still is sometimes used in varnish manufacture and as a fixative for microscopic specimens. The lumber, which is light, soft, weak, coarse-grained and perishable, is used mostly for pulp and building packing-crates. The leaves have long been harvested and made into aromatic "balsam pillows," currently marketed to tourists in souvenir shops of the Northeast. The most important use of balsam fir is as a premium Christmas tree, noted for its aromatic, dark green, persistent and soft-tipped leaves and the natural, conical shape of the crown. Large quantites of seeds are collected and seedlings purchased each year for Christmas tree plantations. This fir is of little use as an ornamental except for a few cultivars that have propagated from side- branch cuttings. These are marketed as dwarf conifers, although many do not remain dwarfs without pruning.

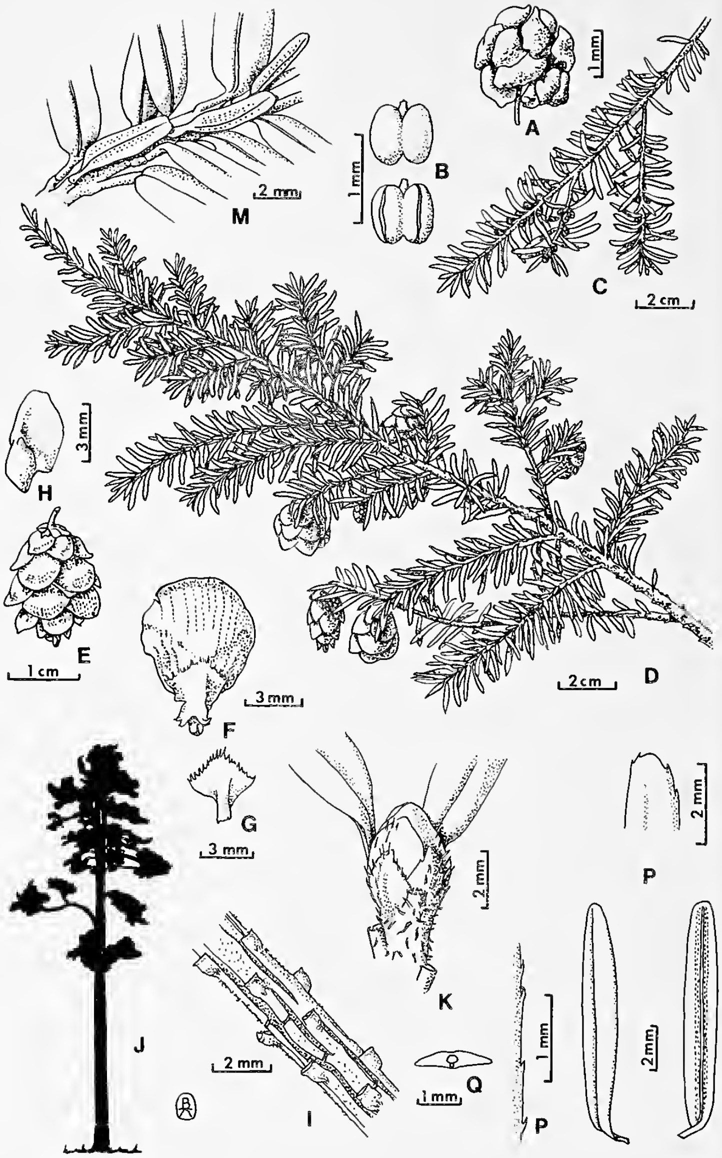
5. TSUGA

Common Names: hemlock, hemlock-spruce

Authority: Carrière, Traité Gen. Conif., p. 185, 1855

A genus of 10 species native to north-temperate North America and Asia. *Tsuga heterophylla* (Raf.) Sarg. and *T. mertensiana* (Bong.) Carrière, are native to northwestern North America, *Tsuga caroliniana* Engelm. is native to the southeastern U. S., and *T. canadensis* (L.) Carrière the northeastern native species. Hemlocks are easily recognized by their graceful habit with pendulous leading shoots, short linear leaves of different sizes on the same branchlet, and small pendulous cones with small bracts concealed between the scales. *Tsuga* species are variable, showing some obvious links in growth habit, leaf, branchlet, pollen and female cone morphology to certain other genera of Pinaceae. Using these characters, Page (1989, 1990) recognized two genera: *Nothotsuga* H.H. Hu ex C.N. Page, and *Hesperopeuce* (Engelm.) Lemmon. Similar features shared by *Picea* species and *Tsuga mertensiana* were used to justify recognition of the intermediate, monotypic genus, *Hesperopeuce*, and prompted Gaussen (1966) to postulate recent hybridization between *Tsuga* and *Picea*. *Tsuga* also shows some similarities to the Chinese genus *Cathaya*. The New York native hemlock, *T. canadensis*, has easily proved the most economically important species of the genus, both in the past, when its bark was so desirable for the tanning industry, and presently, as the source of over 250 cultivated varieties.





1. *Tsuga canadensis* (L.) Carrière

Common Names: eastern hemlock, spruce-pine, hemlock-spruce, Canada or Canadian hemlock, hemlock-pine, white hemlock, Wisconsin hemlock-pine, hemlock-fir, red hemlock, tanbark tree, water-spruce, weeping-spruce

Type Description: Linnaeus, Species Pl., ed. 2, p. 1421, 1763

Synonyms: *Abies canadensis* (L.) Michx., *Pinus canadensis* L., *T. americana* Farw.

Origin: Native to northeastern North America

Habitats: Common in dense, shady, often moist forests. Also commonly scattered in open rocky woodlands at edges of bogs and in upland forests, often filling ravines or covering north-facing slopes of rocky ridges, the banks of rivers and streams and even vertical, rocky banks of narrow river gorges. Widely distributed throughout the State

Habit: Medium-sized to large tree, with long, slender branches often drooping, forming a broadly conical crown with a pendulous, flexible apex and a strongly tapering trunk that is often devoid of living branches in its lower two-thirds

Pollination: April-June

Mature Cones Opening: September-October of the 1st season

General Distribution: Nova Scotia west to northern Michigan and Wisconsin, south through New Jersey and western Maryland to northern Georgia and Alabama; disjunct in central eastern Minnesota, southern Indiana and central North Carolina

Description: monoecious; **female cones** terminal, oblong-cylindrical, 5-8 mm long at pollination, becoming 1.3-2.0 cm long, 1.2-1.8 cm wide, erect and purple to pink-tinged green prior to pollination, turning down with the scales becoming tightly appressed and bright green soon after pollination, finally pendulous, open and brown, persistent only through the first winter with gradual dispersal of the seeds; **peduncle** 1.0-2.5 mm long, pubescent; **bracts** flabellate, about 1.5 mm long and broad, 1/3 to 1/2 the length of the young scale, 1/4 to 1/6 the length of the mature scale, brown to purple-brown, membraneous and coarsely laciniate or fimbriate at the broad apex and upper margins, lower margins entire; **female cone scales** obovate to nearly orbicular, concave, 4-6 times as long as the inconspicuous bracts, 4-5 mm long at pollination, 7-10 mm long at maturity, smaller toward the cone apex and base, entire, glabrous, persistent, dark purple, becoming brown, the exposed, slightly-thickened apex of the lower surface light brown to green; **seeds** ovoid-oblong, slightly compressed, nearly half as long as their wings, 2-3 mm

long, 1.5-2.0 mm wide, broad at the base and gradually tapering to the rounded apex, light brown, with 2-3 resin vesicles, **wing** obovate-oblong, sail-shaped, rounded or obtuse at the apex, attaching obliquely to the seed, 5-6 mm long, about 3 mm wide, pale brown; **cotyledons** 3-6; **male cones** terminal or axillary, crowded or solitary on branchlets of the year, 2.0-2.5 mm in diameter prior to pollination, becoming 4-6 (-9) mm long, about 2 mm wide, light yellow-brown to brown; **sterile scales** 15-20; **peduncle** fragile, slender, naked, about 2.5 mm long, loosely covered at the base by persistent, sterile bud scales; **male cone scales** 10, spirally arranged, but with the appearance of a globose cluster, 1.0-1.5 mm long; **lamina** broadly acute, thickened, appearing as a bump or mucro projecting laterally from the apex of the male cone scale, about 0.1 mm long; **microsporangia** 0.8-1.3 mm long, opening by a longitudinal slit; **pollen** with circular ridge and sculpturing, not winged; **leaves** all similar, but of different sizes and orientations on the same branchlet, spirally arranged, the petioles twisted so that the leaves project upwards or laterally away from the branchlet, often with the 4th leaf of each of 2 spiral series shorter and directed forward along (or parallel to) the upper surface of the branchlet (thus the appearance from the top of the branchlet is that every 8th leaf is flattened against the upper surface) the leaves between the upper parallel blades and the lower horizontal ones of intermediate sizes, blades linear, flat, 3-12 (-18) mm long, 1.0-1.5 mm wide, apex rounded to obtusely pointed (rarely emarginate or notched), green, sometimes yellow-green, sometimes lustrous on the adaxial surface, aromatic when crushed, margins slightly revolute, entire becoming sparsely denticulate toward the apex, persistent several years, resin canal 1, **adaxial surface** grooved at the midrib, lacking stomata, **abaxial surface** with 2 white stomatal bands each consisting of 6 broken rows on each side of the raised pale white midrib and separated from it by a thin band of green that is less than or equal in width to the green margins; **buds** ovoid, acute, 3-5 mm long, light chestnut-brown to red-brown, puberulous; **petioles** usually flattened against the branchlet, 0.5-0.8 mm wide, twisted, white or pale yellow; **bud scales** ovate, thin or membraneous near the upper margins, pubescence decreasing with age, persistent; **petioles** often twisted, usually flattened against the branchlet, 0.5-0.8 mm long, 0.3-0.4 mm wide, white or pale yellow; **branchlets** pubescent, becoming less so with age, rough, thinly grooved, the grooves formed by pulvini or raised decurrent projections of the twig where the leaf is attached, pale brown becoming gray, pubescent but becoming sparsely so with age; **branches** long, slender, slightly ascending to horizontal, then flexible and pendulous at the very tip, especially during the season of maximum growth, irregularly and pinnately ramified, borne irregularly on the trunk, the lower 2/3 of which is often bare, or branches may be persistent to the base, even under forest conditions; **bark** 1.5-7.5 cm thick, deeply fissured into narrow rounded plates and ridges covered with close scales, red-brown to gray tinged with purple or gray-brown, cinnamon-red (and astringent) below the surface; **crown** broadly conical becoming slightly irregular with age, the long, slender branches often pendulous, the apex pendulous and flexible during much of the year, but stiffening over winter; **trunk** to 1 meter (-2.2 m) in diameter, strongly tapered, often somewhat buttressed at base; **tree** 20-30 m tall; **root system** broadly spreading, the major lateral roots sometimes exposed above ground level ($2n = 24$).

Infraspecific Variation: *Tsuga canadensis* harbors considerable genetic diversity, as has been demonstrated by the many cultivars that breeding has yielded. Variable growth rates, in addition to density, length and color of the leaves, define cultivated varieties in a group that, on the whole, expresses little variation in the wild.

Importance: The bark of hemlock is a rich source of tannin that was exploited to a high degree in the 19th and early 20th centuries. The wood is weak, brittle, coarse-grained, difficult to work and not durable, therefore, not valuable for quality lumber. Instead, its light weight has prompted its use for boxes and crates, railroad ties, and, to some extent, log houses, although the rapid taper of the bole limits this application. The wood has also been used for pulp. Oil of hemlock, distilled from the young branches was once an important product, used mostly as a veterinary liniment. Native Americans and early colonists extracted the bark for teas, beers, dyes and a great variety of medicines. The principal economically important use of the plant today is as an ornamental. The tree is planted for shade, but most of the horticultural interest is in its plethora of varieties. Vegetative variation within the species has offered abundant opportunity for development of over 250 cultivars, propagated mainly by rooted cuttings and grafts. Dwarf cultivars are of particular interest, and the more desirable of these often command a high price.

6. PICEA

Common Name: spruce
Authority: A. Dietrich, Fl. Geg. Berlin, p. 794, 1824

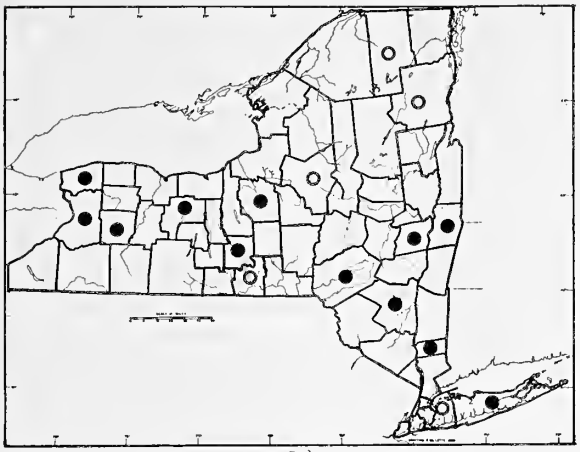
Picea is genus of about 35 species of trees, widely distributed, mostly at high altitudes, in the Northern Hemisphere. Eight species are native to North America, five in the west, two in the east, and *P. glauca* (Moench) Voss spans the northern part of the continent. Research on the systematics of the genus indicates weak genetic barriers among species with the presence of natural hybrids (Bobrov, 1972). It has been postulated that the most important prerequisites for speciation in the genus, then, would be geographic isolation and variation in phenology (Wright, 1955). This premise has not been challenged by investigations of characters such as seed-scale morphology, pollen grain size, leaf anatomy and morphology, endosperm isoenzymes and other chem-

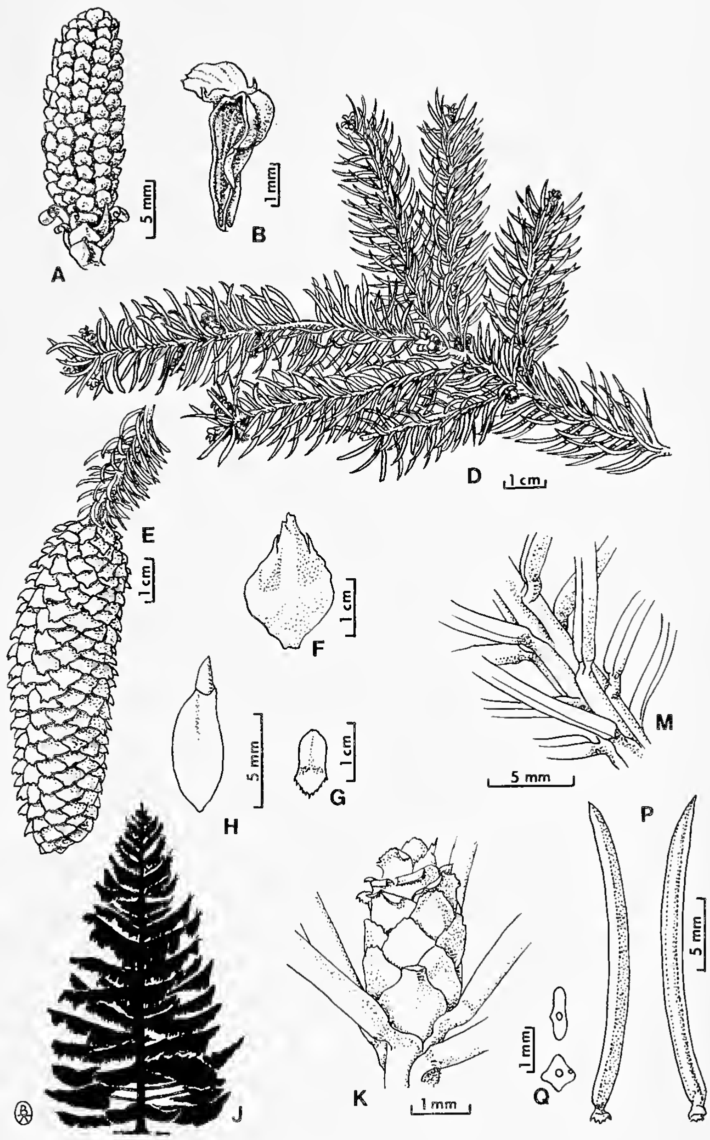
ical characters (Alden, 1987; Schantz and Juvonen, 1966; Wellendorf and Kaufmann, 1977; Wellendorf and Simonsen, 1979). Earlier classification schemes placed spruce species in three sections: *Picea*, *Omorika* Willk. and *Casicta* Mayr, mostly based on flatness of the leaves, amiphistomatic vs. hypostomatic leaves and thickness of female cone scales. Most researchers have abandoned this classification, although Alden (1987) retained placement of the species in two sections, *Picea* and *Castica*, while admitting that their use has limited application. Schmidt (1989) also found spruce female cone morphology of use in supporting division of the genus into two subgenera or sections. Spruces are economically important for lumber, pulp and landscape plantings, and they are extensively cultivated. *Picea glauca* is planted in large numbers in Christmas tree plantations in northeastern North America, particularly in New York State. European *P. abies* Karst., Norway spruce, is ubiquitous as a planted tree of old lawns, parks, cemeteries and streets in eastern North America, as well as escaping from plantations into the wild. *Picea pungens* Engelm., the blue spruce of the Rocky Mountains, is also cultivated extensively as a lawn tree and prized for its bluish foliage and dense, symmetrical growth. It is reported as a rare escape in New York State. *Picea glauca* is the only native northeastern species popular in cultivation, but exotic species such as *P. omorika* (Pancic) Purkyne, Serbian spruce, are planted to a considerable extent. Over 350 cultivars of *Picea* have been developed for the nursery trade.

Description: monecious; **female cones** pollinated in spring of the first year after initiation, fertilized and maturing during the same year, terminal, subterminal or scattered along branchlets of the year, sessile, erect, globose, subglobose or ovoid, and green or purple when young, becoming oblong-cylindric, pendulous, peduncled, brown or red-brown; **peduncles** 1-4 mm long, thick, covered with sterile cone scales, soon twisting so that the cone becomes pendulous; **bracts** reduced, concealed, oblong or spatulate to orbicular, 1-4 mm long, 1.0-2.5 mm wide, quickly surpassed by the cone scales, the apex toothed, midrib projecting as a mucro or short subulate awn, brown to dark brown; **female cone scales** many, thin, oblong, the apex usually erose or sometimes notched, the exposed abaxial apex lighter brown or yellow-brown and often thicker, a few scales at the apex and the base usually reduced and remaining closed; **ovules** acute or divided at the apex (micropylar end), projecting just beyond the margin at the very base of the subtending scale; **seeds** rhombic, obovate or ovate, rounded on the sides, gradually narrowed to an obliquely acute or obtuse base, lacking resin, **wing** membraneous, obliquely obovate or wedge-shaped, obliquely attached to the seed, pale brown; **cotyledons** 4-15; **male cones** solitary, oblong-cylindrical, borne at the tips or scattered laterally along the branchlets; **sterile scales** 25-35 in four series, similar to branchlet bud scales, scarious, the outer ones hardened and broadly keeled, the inner longer and more transparent; **peduncles** up to 2 cm long, usually concealed by the sterile bud scales; **male cone scales** numerous, oblong, usually 1-3 mm long, yellow-brown to red-brown, glabrous; **lamina** 0.5-1.5 mm long, 0.5-2.0 mm wide, **microsporangia** opening longitudinally; **pollen** winged; **leaves** solitary, spirally arranged, radiating in all directions from the branchlet, or those on the adaxial branchlet surface directed upwards (particularly true of fertile branchlets and those toward the apex of the tree), borne on decurrent woody pegs or sterigmata that project 0.5-1.0 mm from the branchlet and detach with the leaf when green, but remain when leaf is left to turn brown and fall, 4-angled, therefore with 2 adaxial and 2 abaxial surfaces (those of some species outside New York more bifacially flattened, with essentially 2 surfaces), sometimes extremely bilaterally flattened, so that the leaf cross-section is 3 or more times deeper than wide, 6-20 mm long (in ours), 0.5-2.0 mm wide (in ours) acute, often pungent, resin canals 1-2, leaves amphistomatic (in ours) or stomata on upper surface only in some species, occasionally hyperstomatic, persistent for 7-30 years; **buds** ovoid, red-brown; **bud scales** many, mostly persistent, imbricate, appressed, ovate, acuminate, the tips of the outer scales spreading or reflexed, those at the base of the terminal bud often with midrib projecting as a subulate arista or awn 1-2 mm long (or as long or longer than the scale); **branchlets** orange to red-brown for 3 years, brown to dark brown thereafter, glabrous or pubescent, roughened by the persistent, decurrent, raised, hardened, woody leaf bases; **bark** very thin, scaly, red-brown to brown or gray; **crown** conical, symmetrical; **trunk** to 1 m or more in diameter, often devoid of branches on the lower half or with persistent dead branches; **trees** tall, straight, with irregular or regularly whorled branches; **root system** usually spreading, shallow to moderately deep.

KEY TO SPECIES

1. Female cones 9-18 cm long; trees with long sweeping branches; lateral branchlets pendulous, glabrous ....1. *P. abies*
1. Female cones 1-5 cm long; branches short, horizontal or ascending; lateral branchlets horizontal, pubescent or glabrous ....(2)
   2. Branchlets glabrous; buds glabrous; basal bud scales obtuse, acute or short-acuminate; mature female cones 4-5 cm long ....2. *P. glauca*
   2. Branchlets pubescent, usually glandular-pubescent; buds pubescent; basal bud scales long-acuminate or aristate; mature female cones mostly 4 cm long or less ....(3)
3. Leaves mostly 6-12 mm long, intially glaucous, straight; female cones usually persistent for several years, mostly 2-2.5 cm long, the scales strongly erose ....3. *P. mariana*
3. Leaves mostly 12-15 mm long, not glaucous, curved; female cones deciduous in the first or second year, mostly 3-4 cm long, the scales entire or slightly erose ....4. *P. rubens*





1. ***Picea abies*** **(L.) Karsten**

Common Name: Norway spruce

Type Description: Linnaeus, Species Pl. II, p. 1002, 1753

Synonyms: *Picea rubra* A. Dietr., *non* Link, *P. excelsa* Link, *Pinus abies* L., *Pinus picea* Duroi

Origin: Native to northern Europe

Habitat: Escaped from cultivation in woods, shaded places, borders and old fields, the seedlings sometimes establishing in profusion in clearings near forest plantings

Habit: Medium to large tree with a straight trunk and broadly conical crown, with long, sweeping branches that ascend at the tips, these persistent to the trunk base in open conditions, the lower 1/3-2/3 of the branches often dying, but remaining on the tree for years in forest stands and plantations, making them almost impenetrable

Pollination: April-June

Mature Cones Opening: August-September of the 1st season

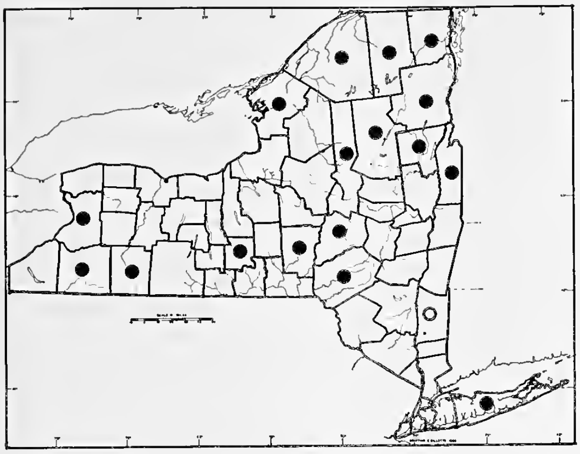
General Distribution: Central and Northern Europe, cultivated extensively and naturalizing in eastern North America from scattered trees grown in open areas as well as plantations and reforestation projects

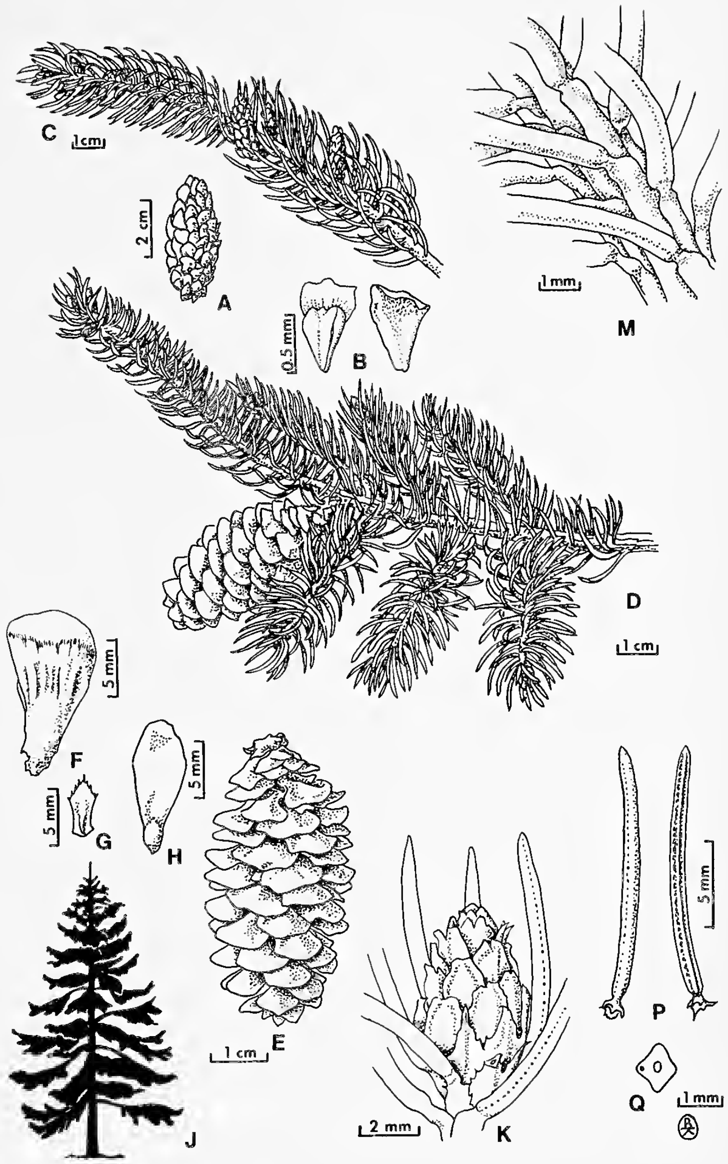
Description: monoecious; female cones terminal, cylindrical-oblong, 9-18 (-25) cm long, 4.3-5.0 (-6) cm wide, bright purple when young, becoming light brown, lustrous; **bracts** oblong, acute; **cone scales** obovate to oblong-obovate, 18-25 mm long, 15-20 mm wide, slightly concave, the apex tapered then truncate, crenulate to erose and often emarginate, the exposed portion thickened, apical margin thinner and tending to curl upward, light brown where exposed, darker brown where covered by the subtending scales; **seeds** obovate, wedge-shaped, the base acute, 3.0-4.5 mm long, 1.7-2.0 mm wide, light brown to dark brown or almost black, glabrous, **wing** obovate, wedge-shaped, 9-17 mm long, 5-7 mm wide, light brown, lustrous; **male cones** oblong-cylindrical, slightly tapering at the apex, 16-27 mm long, about 7 mm wide, light brown; **peduncle** 2-3 (4.5) mm long, usually partially hidden by persistent bud scales; **male cone scales** numerous (up to 200), oblong, about 3 mm long; **lamina** 0.9-1.5 mm long, about 2 mm wide, laciniate, light brown; **leaves** spirally arranged, oftened spreading horizontally to give the branchlet a flattened appearance, the persistent bases or sterigmata of the lower branchlet surface twisted, the leaves curved, projecting upward from the branchlet, therefore those on the sides and lower branchlet surface each having 1 adaxial and 1 abaxial surface facing upward, usually more flattened bilaterally than bifacially, therefore, often thicker than wide, 12-20 mm long, 1.0-1.5 mm wide, abruptly acute, often hard and sharp at the tip, green, persistent at least 7 years, stomata arranged in (3) 4-5 (-

7) rows on the two **adaxial** surfaces and 3-5 (6) rows on the 2 **abaxial** surfaces, usually increasing in number toward the apex, the midrib or angle usually equally and strongly elevated on both surfaces; **buds** ovoid to conical, (2-) 4-8 (-10) mm long, the apex often with ragged appearance from the early spreading of the scale apices, red-brown to light brown, barely resinous; **bud scales** many and variable, broadly ovate, concave, 2-3 mm long, upper margins and apex ciliate, sometimes shortly keeled at the acute apex, red-brown to brown, glabrous to minutely puberulent near the apex, the outer or basal scales of the terminal bud often with a subulate or awn-like extension at the apex, the awn 0.5 (-1) mm long and often surpassing the apex of the bud; **branchlets** horizontal, usually becoming pendulous, light brown to orange-brown in the 1st 2 years, becoming brown or gray-brown, usually sparsely and minutely puberulent or rarely densely glandular-pubescent the 1st year, glabrous or occasionally pubescent thereafter, the grooves or exposed parts of the branchlets between the decurrent sterigmata broad; **branches** long (to 6 m in open conditions), stout, pendulous, ascending and turning upward to nearly erect at the tips, the numerous lateral branchlets pendulous; **bark** thin, less than 1 cm thick on older trees, tight, slightly roughened or smooth, red-brown, becoming light gray, developing small scales or flakes that gradually fall off larger and older trunks; **trunk** to 75 cm or more in diameter, with branches persistent to the ground in open conditions, the bottom branches with the ability to layer, in forest stands the lower 1/3-2/3 of the branches remaining on the tree for many years; **crown** usually broadly conical, occasionally narrowly conical; **tree** to 40 (-50) m tall; **root system** spreading, shallow to moderately deep (2n = 24).

Infraspecific Variation: A very large number of horticultural varieties of *P. abies* are established in the cultivated flora of the world, and many of these are grown in New York. Variation throughout the natural range of Norway spruce is extensive, with several botanical varieties and forms having been described in Europe. Branchlet vestiture (absence, presence, density and glandularity), leaf characters (orientation on the branchlet, shape, color, arrangement of stomata and resin canals), cone and cone scale characters (size and shape) all show a wide range of variation in the wild in Europe (Lindquist, 1948), and variation is less, but evident in North American trees as well. Branches are typically long and sweeping, but they can be more erect, shorter and stiffer, with branchlets less pendulous. This variation combined with more angular leaves that do not spread horizontally along the branchlets can make this spruce look similar to *P. glauca*. *Picea abies* var. *obovata* (Ledeb.) Hultén is a widely recognized variety cultivated to a limited extent in this country, and it may have escaped. These trees have densely pubescent twigs and shorter female cones, and the leaves and obovate female cone scales have rounded apices.

Importance: Historically, this species was an important lumber and pulp producer in Europe, used for ship-building and a variety of other purposes. Norway spruce has been a tree of significant economic value in North America as well. Introduced early to this country, it has been planted extensively for ornament, windbreaks, as a street tree and in cemetaries. It continues to be planted for reforestation purposes as well. Rapid loss of leaves after cutting severely limits its use as a Christmas tree. The tree is beginning to be harvested for pulp and construction, and rarely for log houses.





2. *Picea glauca* (Moench) Voss

Common Names: white spruce, cat spruce, Canadian or Canada spruce, skunk spruce, single spruce

Type Description: Moench, Verzeich. ausl. Baum. und Stand., p. 73, 1785

Synonyms: *Abies alba* Michx., *A.canadensis* Mill., *Picea alba* (Michx.) Link, *P. canadensis* (Mill.) BSP., *P. laxa* Sargent, *Pinus glauca* Moench, *P. alba* Ait.

Origin: Native to northern North America

Habitats: New York State, in vernally moist areas flanking the northern Adirondacks, from limestone, alvar associations to more acidic flatrock communities, seeps and slopes to middle elevations, also escaping cultivation in other parts of the State. Northward in its range, in low, moist, alluvial soils, often along stream banks, shores of lakes and ponds, on moist hillsides and the borders of swamps, woods and open areas, high elevations to boreal salt-sprayed sea cliffs

Habit: Small to large tree with a narrow, conical crown that becomes broader, often irregular or open with age, the long, rather stout, upcurving branches persisting on the trunk to ground level except in dense forest conditions where the lower 1/3 – 2/3 of the trunk may be bare. The plants may be shrubby in arctic-alpine situations

Pollination: May-June

Mature Cones Opening: August-September of the 1st season

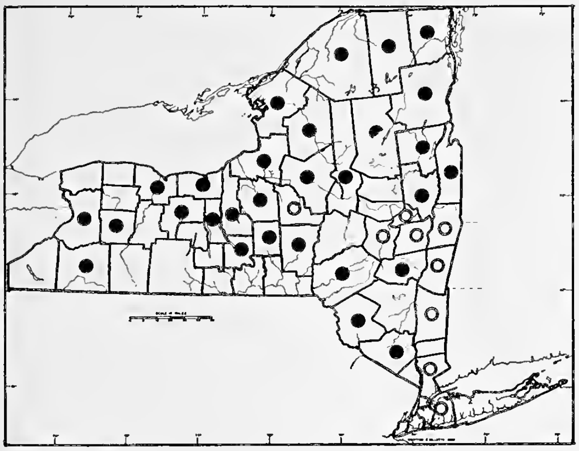
General Distribution: Newfoundland west to Alaska, south to southern Maine, northern parts of New Hampshire, Vermont, New York, Michigan and Wisconsin, northeastern Minnesota, Manitoba, Saskatchewan and northwestern Montana; disjunct in southeastern Michigan and western South Dakota

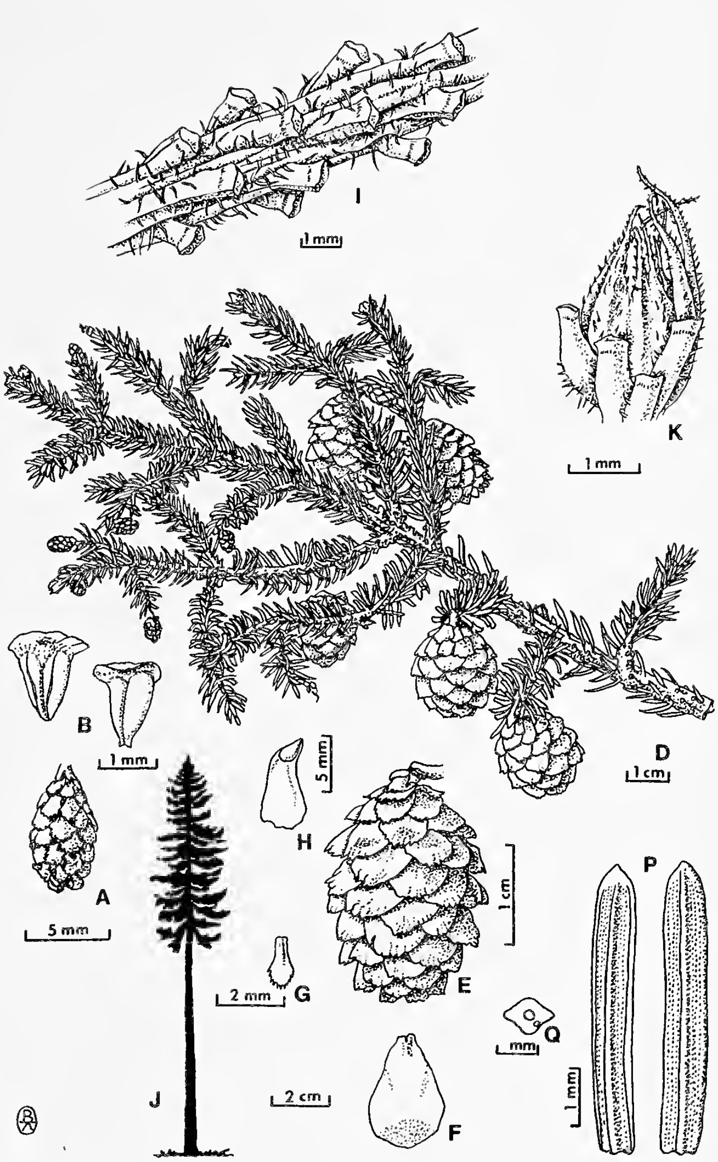
Description: monoecious; female cones terminal or crowded near the tips of the previous year's growth, red or yellow-green and glaucous when young, oblong-cylindrical, slightly narrowed at the apex, (2.9) 3.4-4.8 (5.4) cm long, (1.8) 2.1-2.3 (2.6) cm wide, brown, mostly deciduous the 1st year; **bracts** oblong or pandurate-spatulate to nearly orbicular, 2-4 mm long, 1.5-2.0 mm wide, the apex somewhat narrowed, denticular or notched, upper margins denticulate, purple becoming light brown at the apex to dark brown at the base; **female cone scales** 80-100, including 8-10 smaller unopened scales at the base of the cone and 10-20 immature or unopened scales at the apex, obovate, nearly orbicular in the upper half, narrowing to a broadly cuneate or wedge-shaped base, concave, thin, 9-12 mm long, about 10 mm wide, the apex rounded (occasionally narrowed) and often broadly

emarginate, curling upwards, the exposed apical regions slightly thickened, brittle, brown, lustrous, the margins entire or sometimes erose; **ovules** divided at the micropylar end; **seeds** obovate, about 2 mm long, 1 mm wide, acute at the base, rounded at the apex, dark brown to almost black, **wing** obovate, wedge-shaped, 6-9 mm long, (2.5) 3.5-4.5 (5.5) mm wide, light brown; **male cones** terminal or subterminal, subglose, rapidly becoming oblong-cylindrical, 8-12 mm long, red and yellow, pink, red or red-purple; **peduncle** hidden by persistent bud scales; **male cone scales** about 2 mm long; **lamina** wider than long, about 1 mm long, laciniate; **leaves** spirally arranged, with sterigmata twisted so that the leaves are directed upward and crowded on the upper side of the branchlet, linear, incurved toward the branchlet apex, or straight and curved outward or away from the branchlet, 11-17 (23) mm long, about 1 mm wide and thick, acute, sometimes with rigid, callous, sharp tips, green, blue-green or gray-blue, glaucous, persistent 7-10 years, the sterigmata not projecting more than 0.5 mm from the branchlet, the odor strong and considered bitter and disagreeable by some, **adaxial surfaces** each with 4 rows of stomata, **abaxial surfaces** with 3-5 (-7) interrupted and uninterrupted rows of stomata, the rows increasing in number towards the apex; **buds** ovoid with a broad blunt apex, 3-6 mm long, 2-3 mm wide, the lateral equal in size or slightly smaller than terminal buds, light brown or red-brown, only slightly resinous; **bud scales** slightly appressed, later spreading, broadly ovate, 1.5-2.5 mm long, about 1.5 mm wide, the margins ciliate, the 4 basal scales of the terminal bud deltoid with a swollen yellow base and keeled with the midrib usually elevated into a ridge that extends beyond the apex into a short awn, the awn 0.3-1.0 mm long; **branchlets** stout, 1.5-3.5 mm in diameter, orange-brown or light brown the 1st year, becoming darker or remaining orange in subsequent years, ultimately dark brown, gray-brown or gray, grooves usually gray or black by the 2nd year, glabrous or occasionally sparsely rusty-pubescent in grooves of 1st-year branchlets, often glaucous, at least on sterigmata of 1st-3rd year branchlets; **branches** irregular or regularly spaced in whorls, horizontal, then upturned at the tips, with numerous lateral branchlets horizontal or pendulous; **bark** to 1 cm thick on older trees, gray to gray-brown, separating into thin, plate-like scales; **crown** narrowly conical becoming broadly conical, often irregular or open with age, the long, rather stout, upcurving branches persistent to the ground unless in dense forest conditions where the lower 1/3-2/3 of the trunk may be bare; **trunk** 35-75 (-150) cm in diameter, straight with little taper; **trees** 20-25 (-50) m tall, reduced to shrubby or dwarf stature at at tree line at high elevation or alpine situations; **root system** spreading, shallow to moderately deep (2n = 24).

Infraspecific Variation: Variation in cone and leaf characters is considerable across the range of white spruce. In New York State, cone size is variable but leaf size is rather constant, although orientation and relative flatness of the leaves varies. Leaves are more strongly glaucous at their woody bases, although sometimes the bloom disappears early. The transition from leaf to bud scales is sometimes rapid and sometimes gradual. Some lower bud scales have a scale-like base and a light green foliar apex. Sometimes leaves are more flattened, less glaucous and a darker green, making this species more difficult to distinguish from *P. abies*. *Picea glauca,* in contrast to *P. mariana* and *P. rubens*, with which it is often sympatric, is a relatively recent addition to the flora of New York. In the northern and montane part of the State, post-Pleistocene migration of this western species appears to continue as its range expands (Wright, 1955), while in southern, central and western parts of the State it may be speading mainly by naturalization from forest plantings. Although white spruce hybridizes frequently with Engelmann spruce, *P. engelmannii* Engelm. ex Parry, in the West, there is little or no hybridization with *P. rubens* and *P. mariana* (La Roi *et al.*, 1968; Little and Pauley, 1958, Wright, 1955). *Picea glauca* var. *albertiana* (S. Brown) Sarg. is a variety from western North America with shorter, wider, darker female cones, rounded female cone scales, smaller, sharply angled bracts and leaves spreading at nearly right angles to the twig.

Importance: The soft fibers of its light, fine-grained, weak wood make white spruce the most valuable pulpwood of northeastern and north central North American forests. Construction lumber and sounding boards for musical instruments are other uses. The roots were used by native Americans for canoes and basketry. Leaves, bark and the other parts of the plant were apparently also used for medicines, poultices, gums and teas. Despite the general tendency of spruces to drop their leaves soon after cutting, white spruce holds its leaves longer, grows rapidly, and supplies a large portion of the Christmas tree market in New York and other northeastern states. White spruce is popular in cultivation as a specimen tree, hedge or windbreak. About half of its 30-40 cultivars are dwarf varieties.





3. *Picea mariana* (Miller) BSP.

Common Names: black spruce, bog spruce, swamp spruce, shortleaf black spruce, bay spruce, eastern spruce, he-balsam, spruce gum-tree, double spruce, shite spruce, water spruce, shortleaf spruce

Type Description: Miller, Gard. Dict. ed. 8, no. 5, 1768

Synonyms: *Abies mariana* Mill., *Picea brevifolia* Peck, *P. nigra* Link

Origin: Native to northern North America

Habitats: Mainly cold slopes, bogs, swamps and lake shores, rarely on drier, better-drained uplands and rocky slopes in association with *Larix laricina* to tree line in the Adirondacks, characteristic of sphagnum-heath bogs in the southern part of its range

Habit: Medium-sized tree with narrow irregular crown and short branches and narrow, straight trunks or sometimes a prostrate mat on mountaintops at treeline, usually with dead branches

Pollination: May-June

Mature Cones Opening: August of the 1st season

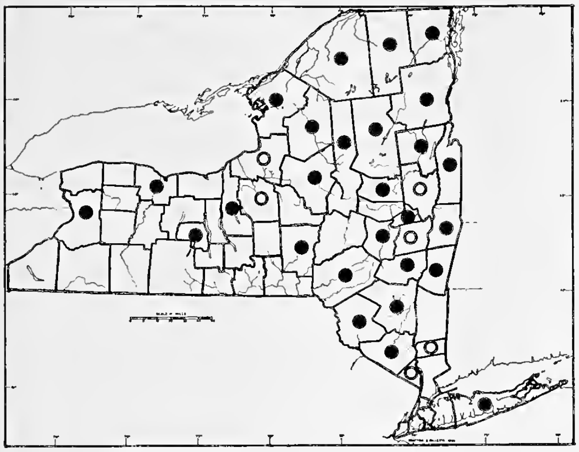
General Distribution: Newfoundland west to Alaska, south to northern New Jersey, northern Pennsylvania, northern Michigan, northern Wisconsin, northeastern Minnesota, Manitoba, central Saskatchewan, central Alberta and east-central British Columbia; disjunct in southeastern Michigan, southeastern Wisconsin and eastern Minnesota

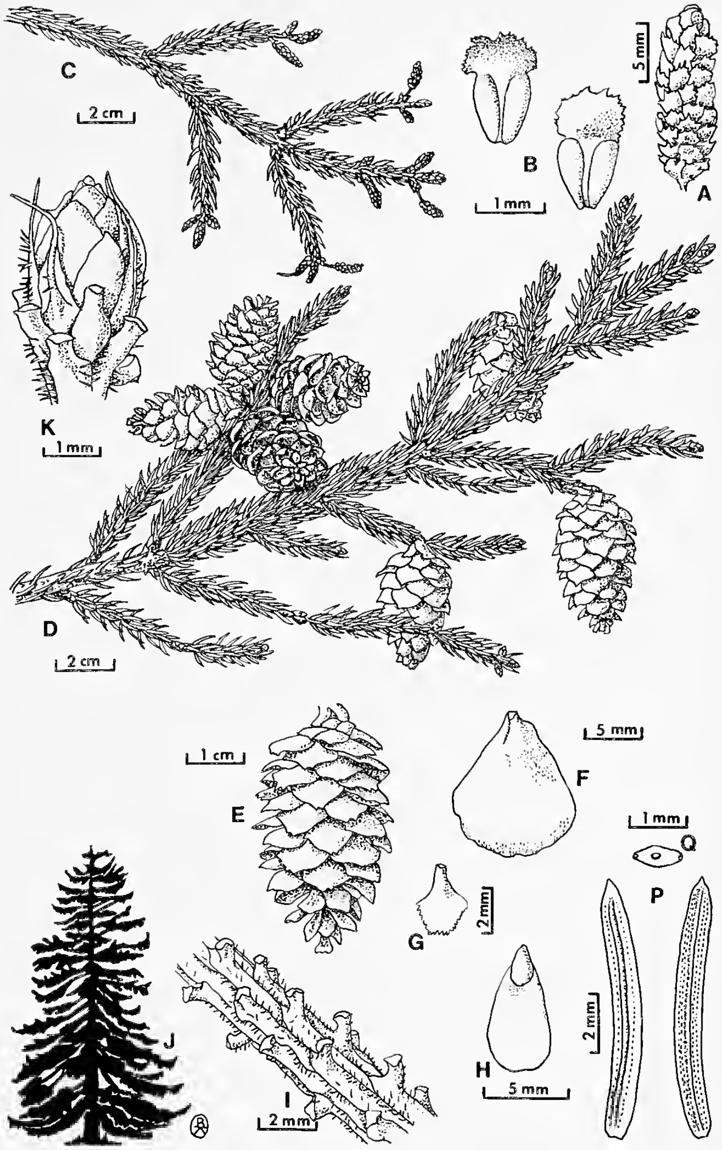
Description: monoecious; female cones terminal or subterminal on the previous year's growth, often crowded, 3-4 mm long at pollination, becoming (1.7) 2.1-2.6 (3.3) cm long, (1.6) 1.9-2.2 (2.4) cm wide, the apex rounded, purple, becoming dark brown, persistent up to 30 years or more; **bracts** spatulate, about 1 mm long, dark purple, laciniate; **female cone scales** about 50, including smaller, basal scales and unopened scales at the apex, obovate nearly spatulate, concave, thin, the largest scales in the middle of the cone about 1 cm long, 6 mm wide, the exposed area near the apex slightly thicker, apex thinner, light brown to dark brown or almost black, minutely puberulous or glaucous on the adaxial surface near the apex, upper margins and apex erose, finely and regularly toothed (or rarely entire), basal margins entire; **seeds** obovate, about 2-3 mm long, 1.2-2.2 mm wide, acute at the base, light brown to dark brown, sometimes mottled, **wing** 4-7 mm long, 2.5-4.0 mm wide, obliquely rounded at the apex, narrowed at the base; **male cones** globose when young, becoming oblong-conical, 8 (-10) mm long, about 3 mm wide; **pedun-**

cle 1-2 mm long, mostly concealed; **male cone scales** 70-100, 1-2 mm long, brown to light red-brown or dark red; **lamina** about 0.6 mm in diameter, laciniate; **leaves** spirally arrranged, radiating from all sides of the branchlet, slightly curved, 6-13 mm long, 1.5-2.8 mm wide, acute, infrequently acuminate, sometimes obtuse, sometimes short, sharp, with callous tips, blue-green, green or dark green, glaucous, lustrous, persistent at least 5-6 years, **adaxial surfaces** with 5-6 rows of stomata each, **abaxial surfaces** usually with 4 rows of stomata each; **buds** ovoid, 3-5 mm long, the lateral ones often smaller than the terminal bud, acute, red-brown to light or dark brown, slightly resinous; **bud scales** ovate, concave, 1-2 mm long, 1.0-1.5 mm wide, ciliate, puberulous, the adaxial surface of the base swollen and yellow, the midrib of the outer scales of terminal buds and occasionally of the upper lateral buds extended into a short-hispid awn about 1-2 mm long, usually surpassing the apex of the bud; **branchlets** grooved due to raised margins of the strongly decurrent leaf bases, yellow-brown or pale red-brown the 1st year, becoming light cinnamon to orange-brown the second and third years, brown, dark brown, gray-brown, gray or blackened thereafter, densely glandular pubesecent, the hairs pale or red-brown becoming darker and finally deciduous; **branches** irregularly arranged, pendulous then turning up at the tip, ascending only near the very top of the tree, short, persistent to the ground in open conditions or extending halfway down trunk in forested conditions, the lowest branches sometimes layering; **bark** 7-15 mm thick, fissured, covered by irregular, thin, close scales, red-brown, becoming gray or gray-brown with age; **crown** frequently irregular, conical; **trunk** 30-50 (-100) cm in diameter, straight, with little taper; **trees** to 20 (-30) m tall, sometimes dwarfed under severe conditions; **root system** spreading, shallow, flat, not windfirm (2n = 24).

Infraspecific Variation: This species is variable in growth habit, with irregular to quite symmetrical crowns and tall to short and stunted growth in bogs and at tree line, where plants a few feet tall sometimes bear cones. Soils and microclimate can drastically affect morphology, so that this species can easily be confused with *P. rubens*, especially where they grow together at lower elevations on the margins of bogs and swamps. These species hybridize in nearly every place where they are sympatric (Gordon, 1976; Heimburger, 1939; Manley, 1972, 1979), although perhaps infrequently, yielding inferior adaptive characters. The color shape and length of leaves and the density and degree of glandularity of pubescence are critical characters that show the greatest variation in *P. mariana*. Cone size is reasonably constant, although slightly larger cones, borne occasionally towards the tips of branchlets, can look much like those of *P. rubens*, whose cones are very nearly the same size and shape. *Picea mariana*, although not completely restricted to bogs and swamps, is not nearly as prevalent in mesic high-altitude sites where red spruce is much more likely to be present. The shorter, curved, glaucous, blue-green leaves, smaller, persistent cones and ability of plants to layer help to distinguish black spruce from the similar and often sympatric red spruce.

Importance: The most important use of black spruce is for pulp, although it is not harvested nearly as much as other spruces for this purpose, because of its slow growth. The light, soft, weak, stiff, straight-grained wood is similar to other spruces, and it is used for canoe paddles, oars, masts, ladder tails and boat construction. Chewing gums, beer, tea and medicine were some colonial and pre-colonial uses of black spruce. Some dwarf horticultural varieties have been developed, but, otherwise, the trees rarely make good ornamental specimens, even under the best of conditions in botanical gardens.





4. ***Picea rubens*** **Sargent**

Common Names: red spruce, he-balsam, yellow spruce

Type Description: Sargent, Silva, vol. XII, p. 33, 1898

Synonyms: *Picea rubra* (Duroi) Link, *P. australis* Small

Origin: Native to eastern North America

Habitats: The common spruce of the Adirondacks and Catskills, where it thrives in shallow, well-drained soil, cold, moist mountain slopes, sometimes at the peaks, and, at the margins of streams and swamps with *P. mariana* and *Larix laricina*, often in association with beech, maple and yellow birch. Occasionally it is found at high elevations, rarely near bogs in central New York, but an important tree of bogs in southern and western New York. Most southerly populations destroyed by a Long Island hurricane, over five decades ago

Habit: Small to medium-sized, slow-growing tree with a narrow, irregular to symmetrically conic crown and a trunk of little taper (dwarf and shrubby at high elevations)

Pollination: April-May

Mature Cones Opening: August-September of the 1st season

General Distribution: Nova Scotia west to southeastern Quebec and southeastern Ontario, south to northern New Jersey northeastern Pennsylvania and south in the Appalachians to western North Carolina and eastern Tennessee

Description: monoecious; female cones terminal or scattered along growth of the previous year, occasionally crowded, (2) 3.3-3.8 (4.2) cm long, (1.9) 2.2-2.5 (2.7) cm wide, green, dark red-green, purple or brown and glaucous, becoming light brown to dark brown, deciduous the 1st winter or spring after ripening, occasionally remaining on the tree another year; **bracts** spatulate or nearly pandurate, 2-3 mm long, about 2 mm wide, finely laciniate, purple becoming brown, glabrous, very soon surpassed by the scales; **female cone scales** 50-60, not including 4-6 much smaller scales at the base of the cone and many unopened scales toward the apex, broadly obovate, adaxially concave, stiff, the middle and largest about 12 mm long and 11 mm wide, thickened near the apex, then thinner and flexible at the margins, the apex rounded and entire, or sometimes minutely erose when young, red-brown, glabrous, except sometimes minutely red-puberulous around the tips of the seed wings; **seeds** wedge-shaped or obovate, cuneate at the base, 1.5-3.0 mm long, dark brown, **wing** wedge-shaped or obovate, 6-7 (-9) mm long, 3-5 mm wide, light brown; **male cones** oblong-cylindrical, 14-19 mm long, 5-6 mm wide, purple-brown to dark purple; **peduncle** 4-5 mm long; **male cone scales**

60-75 (-100), 1.3-1.8 mm long, 1.2-1.5 mm wide; **lamina** 1.2-1.5 mm long, the margins erose to laciniate or irregularly toothed, light brown; **microsporangia** light brown to yellow-brown; **leaves** 10-12 (-15) mm long, 0.6-1.0 mm wide, straight, acute, sometimes mucronate, green or light green to nearly yellow-green, aromatic, with the odor of orange-rind, persistent at least 6 years, stomata arranged in 4-6 longitudinal rows on the adaxial surfaces and 2-3 rows on abaxial surfaces; **buds** ovoid, the terminal sometimes larger than the lateral, 3-5 mm long, 2.0-2.5 mm wide, dark purple to dark brown, often light brown at the base; **bud scales** ovate, about 2 mm long, 1.5 mm wide, acute, carinate and swollen at the base, light brown or yellow-brown, sparsely hispid or glabrous, but consistently becoming glabrous towards the apex, persistent, the outer scales of terminal buds aristate-acuminate, usually surpassing the bud apex, the extension of the midrib or awn at least 2 mm long and hispid, sparsely hispid or glabrous but becoming glabrous towards the tip; **branchlets** opposite or irregularly arranged, usually stout, deeply furrowed, rough to the touch because of the sterigmata or woody projections at the leaf bases, 1-4 mm in diameter, pale yellow to light red-brown the 1st year, becoming red-brown, orange-brown or brown the 2nd year, brown or gray-brown thereafter, glandular-pubescent, rarely glabrous, the hairs pale red-brown to brown, persistent, glands soon deciduous; **branches** numerous, irregular, drooping slightly, then turning up at the tips, the upper branches slightly ascending; **bark** 7-15 mm thick, red-brown, fissured and covered by irregular, thin, close, flaky scales; **crown** narrowly conical; **trunk** reaching 1 m in diameter, with very little taper, the branches persistent on the stem and clothing it to the ground, or lacking on the lower 2/3 of the tree when crowded; **tree** to 30 m tall (often dwarfed and shrubby at hugh elevations); **root system** shallow, wide-spreading (2n = 24).

Infraspecific Variation: Much of the morphological variation in red spruce is mediated by environmental influences (Wright, 1955). Leaves and cones may be shorter when the tree is growing in saturated soils, thereby obscuring its distinction from black spruce, with which red spruce sometime grows and naturally hybridizes. Introgressive hybridization between these species was initially thought to be extensive, but hybrid vigor is so weak that the chance for establishment of hybrid populations is small, and gene flow is not stronger in one direction than another (Gordon, 1976; Manley, 1979). Crown form, branch angle and phenology are some principal characters that show hybrid intermediacy (Khalil, 1987), while leaf length, degree of straightness of the leaves, leaf color and cone size are variable within each species. Longer, straighter, less glaucous or non-glaucous leaves, larger, more lustrous red-brown cones that are early-deciduous (after one or at most two years) and lack of layering, in most cases, reliably distinguish red spruce from black spruce. As with some other species, the range of *P. rubens* has expanded into the Northeast from northwestern refugia as well as from the south following Pleistocene glacial events. However, this range is probably shrinking, since *P. glauca* and hardwood species are now more successful as colonizers of land where red spruce has been harvested (Manley, 1972; Wright, 1955). This is true despite greater environmental tolerances of red spruce and its success in mixed spruce forests.

Importance: Red spruce has been an important source for sounding boards in musical instruments, because of the excellent resonant quality of its light, soft wood that is also weak and close-grained. These same qualities have restricted the use of its lumber mostly to crates, boxes and a source of pulp. Native Americans used the pitch in making canoes, and a variety of medicinal concoctions. The logs have been used for masts of ships, and the roots in construction of boat hulls. The tree is not popular as an ornamental, because of its slow growth and the cool, moist habitat required to attain healthy appearance.

Cupressaceae (Cypress Family)

The Cupressaceae: a family of mostly small trees and shrubs (to large trees) with 130 species in 21 genera distributed worldwide. Six genera are monotypic, while three genera, *Juniperus* (ca. 60 spp.) of north temperate areas of the globe, *Cupressus* (15 spp.) of western North America, Central America, Asia and eastern Europe, and *Callitris* (14 spp.) of Australia represent about 70 % of the species in the family. Only five species of Cupressaceae, representing three genera, *Juniperus* (3 spp.), *Chamaecyparis* and *Thuja*, are native in northeastern North America. The family is better represented in western North America, where *Cupressus* and *Calocedrus* also occur. The remaining 16 genera are widespread, often with disjunct distributions, in Africa, Australia, eastern Asia and South America. The genera *Cupressus*, *Microbiota*, *Platycladus* and *Thujopsis* (and the artificial hybrid genus, × *Cupressocyparis*) are rarely grown in cultivation in New York State. Several genera of Cupressaceae have species that were once, or remain, important in timber production. Many species have proved to be excellent ornamental subjects. *Juniperus*, in particular, has provided a source of vast nursery production. *Juniperus* is also the natural source for flavoring in gin and cedarwood oil. Oil of cedar is extracted from *Thuja occidentalis L.* Recent research, including Hart's (1987) cladistic analysis of conifers, suggests that most of the Taxodiaceae should be included in the Cupressaceae (Eckenwalder, 1976; Hart and Price, 1990; Price and Lowenstein, 1989). Complete fusion of the bract and scale in the seed-scale complex, similar embryological features, the same chromosome number and non-winged pollen grains lacking prothallial cells are common characteristics of the two families that support their merger. Of the Taxodiaceae, a family of 16 species, native to southeastern

and western North America, southeastern Asia and Australia, only one genus (*Sciadopitys*) can not be included in this recent, broader concept of the Cupressaceae. This is not surprising, since *Sciadopitys* has often been placed in its own monotypic family. *Taxodium distichum* (L.) Rich., baldcypress, of wide distribution in swamps and bayous of the southeastern United States, is not native in New York State, although it is frequently cultivated and has been reported as a rare escape. *Cryptomeria, Cunninghamia, Metasequoia* and *Sequoiadendron* are other genera of the Taxodiaceae cultivated, albeit rarely, in New York State.

FAMILY DESCRIPTION

Evergreen trees or shrubs with spreading to compact conical crowns with short, slender or stout branches and lateral branchlets that are rounded or flattened into pendulous, horizontal or ascending sprays or fan-like clusters. The bark of trunks and large branches of mature trees is fibrous, shredding or peeling in strips. In most genera, plants bear juvenile leaves as well as dimorphic adult leaves, usually with 1 resin canal. Juvenile leaves are whorled to opposite-decussate, linear, linear-lanceolate or sometimes nearly ovate, often subulate, entire, usually concave, with longitudinal rows of stomata in a wide band along the center of the adaxial surface, usually pungent. Juvenile leaves are more prevalent on seedlings, young plants or young, rapidly growing shoots of mature plants, often lacking altogether on mature plants. Adult leaves are often mixed with juvenile leaves on the same branchlet, and transitional leaves are sometimes present. They are small, usually scale-like, sometimes linear, subulate or awl-shaped, entire or minutely serrulate, peristent, decurrent and completely clothing the branchlet. Adult scale-like leaves are opposite (or sometimes whorled), decussate, imbricate, appressed to the branchlet, sessile, the apex sometimes slightly diverging, acute or obtuse, glabrous, entire or minutely serrulate. Some are flattened facially and some bilaterally on the flat branchlets, their basal margins connivent, even if only at the concealed extreme base. The stomata occur in a few short longitudinal rows on each side of the keel, often hidden by the imbricated leaves below. Adult linear leaves are usually whorled, pungent, entire, adaxially concave, with the stomata in a longitudinal band of several rows traversing the length of the leaf on the adaxial surface. The family contains both monoecious and dioecious species. The very small subglobose or oblong male cones are terminal (or lateral) and usually deciduous in the 1st year, the (2-) 6-24 peltate male cone scales with 2-6 (-10) longitudinally dehiscent sporangia, borne adaxially or abaxially on the lower margins, the lamina or apical portion usually about 1.5 mm in diameter, the stalk 0.1-0.3 mm long or lacking. The pollen lacks wings or bladders. Female cones mature in the 1st, 2nd or 3rd year after initiation and sometimes persist for many years after dispersal of the seeds. They are axillary on short, scaly, lateral branchlets or peduncles, globose, subglobose or oblong, with (4) 6-12, spirally arranged ovuliferous scales that are opposite or whorled, peltate or imbricate and flattened, fleshy or woody, and connate or free. The bracts are minute and so fused to the ovuliferous scale that they are macroscopically indistinguishable. The 1-12 (-20) ovules per scale are erect, 2-lobed or 2-pronged, with the micropylar end facing away from the stalk of the female cone. Seeds are wingless or with 1-3 wings, and embryos have 2-6 cotyledons. The chromosome number for the family is uniformly 2n = 22.

KEY TO GENERA

1. Female cones fleshy, berry-like, globose, green, becoming blue or blue-black, the scales never separating at maturity; ultimate branchlets terete; adult scale-like leaves keeled, but not compressed .... 1. *Juniperus*
1. Female cones woody, globose, conical or oblong, green, becoming brown or gray, the scales separating at maturity, peltate or imbricate; ultimate branchlets flattened; adult scale-like leaves compressed bilaterally or facially .... (2)
    2. Female cones globose, the scales peltate; margins of the lateral leaves connivent beyond the apex of the overlapping facial leaf .... 2. *Chamaecyparis*
    2. Female cones oblong or conical, the scales oblong and imbricate; margins of the lateral leaves not connivent beyond the apex of the overlapping facial leaf .... 3. *Thuja*

1. JUNIPERUS

Common Names: juniper, savin, cedar
Authority: Linneaus, Species Pl. II, p. 1038, 1753

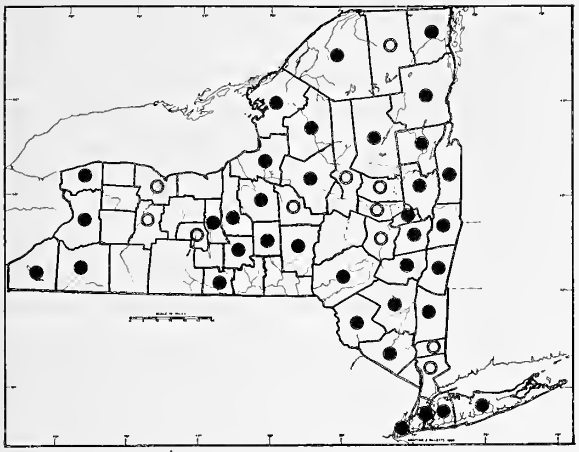
A genus of about 60 species of shrubs and small (to large) trees of the Northern Hemisphere, with about 25 species native to western North America and four species in eastern North America, of which three species occur in New York. Junipers display great variation in growth forms, and horticulturalists and plant propagators have capitalized on this variability to serve many ornamental purposes. *Juniperus* is one of the most widely cultivated conifer genera with over 500 named cultivars in use as hedges, ground-covers, plantings next to buildings, on stone walls in rock gardens and dwarf conifer gardens. Distinctive features are the fragrant or musky foliage, the berry-like, usually glaucous, blue or blue-black cone, and the often persistent, sharp,

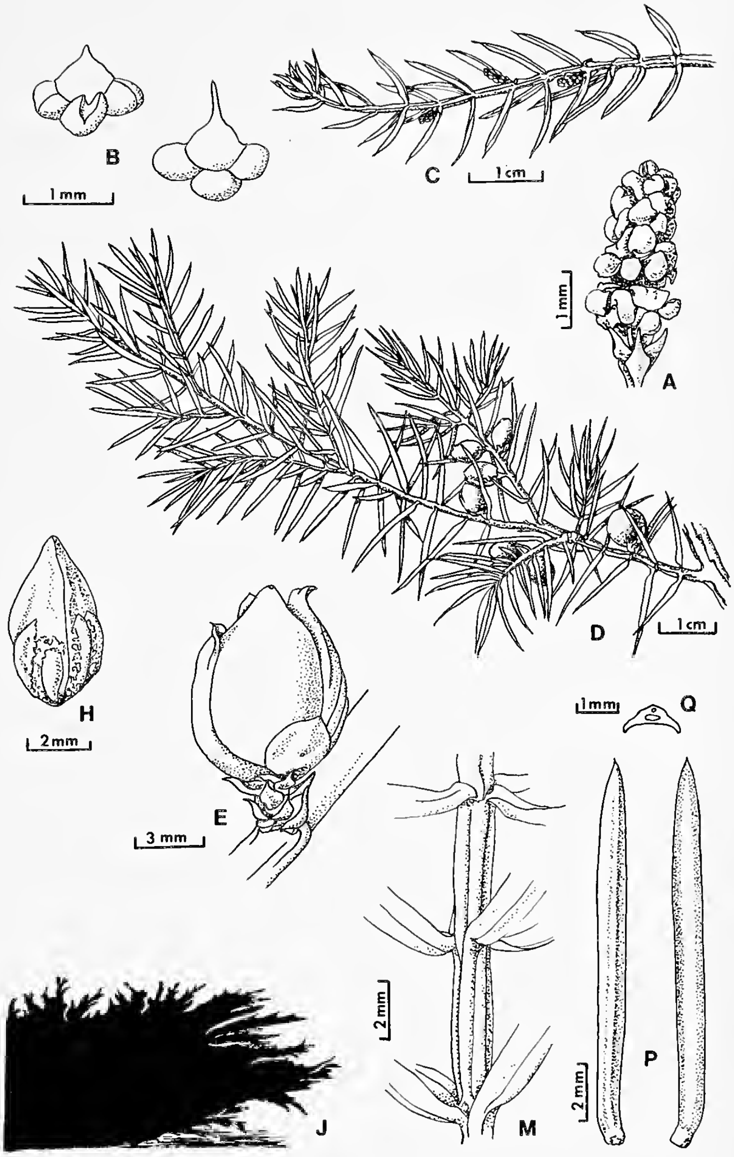
linear, needle-like juvenile leaves. Resinous juices of the "juniper berry" have been used for flavoring in gin distillation, and wood resins are used in production of cedarwood oil.

Description: dioecious (rarely **monoecious**); **female cones** solitary, terminal, on short branchlets (with scale-like leaves) or obscure peduncles (more evident in *J. communis*, which has contrasting, linear leaves) from lateral sterile branchlets borne on the 1st or 2nd year branchlets, erect or pendulous, globose, berry-like, fleshy, green becoming blue or blue-black at maturity, usually glaucous, maturing the 2nd or 3rd year after initiation, resinous, deciduous in the first or second year after ripening; **peduncles** clothed by 2-10 scale-like, opposite, decussate, ovate, appressed or spreading, imbricate leaves, 1- 6 mm long; **sterile scales** 2-6, fleshy, combining with the fertile scales to form the berry-like cone; **fertile female cone scales** 2-6, each bearing 1-2 ovules, peltate, uniting and becoming fleshy, often with a caducous mucro or acute process at the center of the outer surface; **seeds** 1-12, ovoid, acute or obtuse, variously angled, glabrous, light brown, roughened or grooved by the impression of the resin canals of the scales, the hilum 2-lobed, **wings** lacking; **cotyledons** 2 (-6); **male cones** solitary, terminal on lateral branchlets 1-8 (-11) mm long, on the previous year's growth, or axillary and sessile, short oblong-cylindric, 2.0-3.5 mm long, 1.5-2.0 mm wide, light brown to light red-brown; **sterile scales** lacking; **peduncles** naked, abbreviated, concealed by leaves of the branchlet; **male cone scales** 6-12, peltate, often reduced in size at the apex of the cone; **lamina** ovate to orbicular and often surpassed by the swelling and dehiscing microsporangia; **stalk** reduced or not evident, positioned at the lamina margin; **microsporangia** 3-6, attached at the juncture of the stalk and the adaxial surface of the lamina near its basal margin, expanded towards the base of the lamina so that the tips are visible from its abaxial surface, dehiscing longitudinally; **leaves** usually dimorphic (except in *J. communis*), with gradual or sudden transition between adult and juvenile leaves of the same branchlet, the transition often merely an increase in leaf length and greater divergence from the branchlet, transition leaves mostly present on leading shoots and main older branchlets; **juvenile leaves** whorled or occasionally opposite and decussate, sessile, decurrent, imbricate, appressed to and completely covering the branchlet; **adult (scale-like) leaves** not flattened, 2-3 mm long, sometimes achieving lengths over 1 cm on rapidly elongating 2nd-year shoots, acute, the apex subulate in young plants or on rapidly-growing shoots (on 2nd and 3rd year shoots the divergent apex becoming thickened, more keeled and sometimes pungent), bright green, becoming brown and hardened, glabrous, entire, facial and lateral leaves similar, distinguished only by the angle of view, margins of lateral leaves meeting over the basal portion of each facial leaf (this juncture usually obscured by the apical portion of the facial leaf below), with or without raised or depressed resin glands or pits near the middle of the abaxial surfaces of facial or lateral leaves, a few short, longitudinal rows of stomata at the base on each side of the keeled abaxial surface and nearly or completely covered by the apical half of the leaves below; **adult (linear) leaves** (of *J. communis)* whorled, abruptly joined to the branchlet at their broadened bases, concave, pungent, broadly keeled, often appearing swollen on the abaxial surface, the stomata in rows in a broad longitudinal band on the adaxial surface; **buds** scaly or naked; **branchlets** terete, completely covered with leaves, the older ones with grooves or lines formed by persistent adult leaves and decurrent juvenile leaves, the leading shoots and main branchlets with juvenile leaves or longer, more pungent and divergent adult leaves, lateral branchlets with adult leaves only and mostly deciduous; **branches** erect, horizontal or pendulous to prostrate, slender; **bark** usually thin, shedding in long strips, light-brown or gray-brown; large or small **trees** or shrubs; **root systems** fibrous, shallow to deep (2n = 22).

KEY TO SPECIES

1. Leaves linear, in whorls of 3, divergent; berry-like female cones axillary ....1. *J. communis*
1. Leaves mostly scale-like, nearly as wide as long, opposite or whorled, appressed; berry-like female cones terminal ....(2)
    2. Stems prostrate; berry-like female cones pendulous, 6-10 mm wide; seeds 3-5 ....2. *J. horizontalis*
    2. Stems erect; berry-like female cones erect, 5-6 mm wide; seeds 1-2 ....3. *J. virginiana*





1. *Juniperus communis* L.

Common Names: juniper, common juniper, ground juniper, gorst, fairy-circle, horse-savin, hackmatack

Type Description: Linnaeus, Species Pl. II, p. 1040, 1753

Synonyms: *J. communis* var. *siberica* (Burgsdorf) Rydb., *J. siberica* Burgsdorf (see also under var. *depressa*)

Origin: Circumboreal, spanning North America and Eurasia

Habitats: Diverse, from open, stony hillsides to exposed rocky slopes, old fields, pastures, dry, open woods. In dry, poorly illuminated calcareous or acidic soils, swamps, muck or sand up to altitudes of 3,000- 4000 m; also in bogs and limestone crevices of alvar vegetation areas

Habit: Shrub or small tree, often forming dense wide mats, with an irregular, dense to open crown, the trunk small and single or multiple and spreading, the many branches horizontal to prostrate, sometimes adventitiously rooting at ground level, their tips arching upward

Pollination: May

Mature Cones: Variable in ripening and persistence, usually August of the 3rd season

General Distribution: Circumboreal north-temperate and widely distributed in many forms throughout the Northern Hemisphere, from arctic Asia to Japan, the Himalayas and the mountains of the Mediterranean; Newfoundland west to Alaska, south to Oregon and east to Pennsylvania with numerous disjunct populations from California across the Rocky Mountains, south to Arizona and North Texas, northern South Carolina and northern Georgia

Description: dioecious; female cones borne on short, scaly, lateral branchlets or peduncles in axils of leaves of 1st-year branchlets, but not maturing until the 3rd year, drying and often persisting until the 4th or 5th year, erect, spreading, overtopped by the lower scales during the 1st year, globose, subglobose or short-oblong, mostly 7-10 mm in diameter, dark blue to almost black, with pink tinge at the apex of the scales and apex of the ovule in the 1st year, glaucous, sweet, mealy, fleshy, berry-like; **peduncles** 1-2 mm long, the scale-like leaves 10-20, spreading, cuspidate, concave, pale green, becoming chartaceous; **sterile scales** 5-6, ternate; **fertile female cone scales** 3, minute, fleshy, developmentally fused with sterile scales to form a berry-like cone; **ovules** 1 per scale; **seeds** (1-) 3, ovoid, irregularly angled or flattened, acute, deeply pitted with numerous thin-walled resin glands, outer coat thick and bony, the inner membranaceous wings lacking; **cotyledons** 2; **male cones** axillary, on short lateral branchlets or

peduncles, oblong, subglobose to globose, 2.0-3.5 mm long, 1.5-2.0 mm wide, brown; **peduncle** minute, less than 0.5 mm long, covered with 3-6, opposite, decussate, ovate, concave, swollen, green, scale-like adult leaves 0.6-1.0 (-2) mm long; **male cone scales** 8-12, about 1 mm long and about as wide, rounded or acuminate-cuspidate; **stalk** at the margin of the lamina, 0.1-0.2 mm long; **lamina** deltoid or ovate-deltoid, the apex sometimes with a cusp about 0.5 mm long that curls or presses in along the cone axis, often obscured by microsporangia of adjacent male cone scales; **microsporangia** 3-5, about 0.5 mm long; **leaves** in whorls of 3, all linear-lanceolate (except for 6 scale-like, opposite and decussate, imbricate, appressed, concave, ovate leaves about 1 mm long, on the abbreviated lateral branchlets that bear male and female cones), articulating at the point where they become decurrent on the branchet, divergent, often spreading nearly at a right angle to the branchlet, (8-) 10-13 (-15) mm long, 1.5-2.0 mm wide, long-acuminate, pungent, stiff, green turning bronze or brown in winter, glabrous, entire, disarticulating and falling mostly in the 4th year, leaving hardened, decurrent bases that remain on the branchlets for several more years before flaking off, **adaxial surface** concave, with a raised or swollen, light brown area at the point of articulation of decurrent base, with a single, broad, longitudinal, white band consisting of about 15 rows of stomata, **abaxial surface** bluntly keeled by the raised midrib, but also grooved in the middle of the keel, lacking stomata; **buds** ovoid, about 3 mm long, acute, loosely covered by adult or scale-like leaves; **branchlets** completely covered by the decurrent leaf bases, the young branchlets therefore appearing 3-angled, older branchlets terete, about 1 mm in diameter the 1st year, to 4 mm in diameter by the 4th or 5th year, glabrous, lustrous the 1st and 2nd seasons, light yellow or orange-yellow the 1st year, becoming red-brown or brown the 2nd year, dark brown to gray thereafter, rough or scaly with short, raised, swollen areas formed from the midribs of the persistent decurrent leaf bases, with vertical lines or grooves formed by the separated margins of the decurrent leaf bases, with broken or complete concenctric rings where the leaf disarticulates from its base and the twig; **branches** erect, forming an irregular open bush, or horizontal to prostrate with erect tips; **bark** thin, about 2 mm thick, dark red-brown, separating irregularly into many loose papery persistent scales; **crown** irregular, dense or open, with many erect, horizontal to prostrate branches that turn up at the tips; **trunks** up to 25 cm in diameter on erect plants with a single trunk; **shrub** 1-3 m tall, often forming dense mats as wide as 7 meters, or infrequently a **small tree** 4-7 meters tall; **root system** dense, dark and matted; adventitious roots often present where decumbent branches touch the ground.

Infraspecific Variation: A widespread, polymorphic species. Several varieties and subspecies of *J. communis* have been named, based on growth-habit, branchlet length and aspect, size, shape and other characters of the leaves, as well as fruit and seed size. Over 50 cultivars have been developed by selecting for these variable characters as well as foliage color and crown density. The following varieties occur in the wild in New York State.

KEY TO VARIETIES

1. Shrubs erect, often becoming small trees, 2-12 m tall; leaves 12-21 mm long; berry-like cones 5-8 mm in diameter .... 1a. *J. communis* var. *communis*
1. Shrubs decumbent or forming prostrate mats, rarely up to 1.5 m tall; leaves 8-18 mm long; berry-like cones 6-10 mm in diameter .... 1b. *J. communis* var. *depressa*

1a. *J. communis* L. var. *communis*

Common Name: common juniper

Habitats: Dry soils of woods and clearings

Habit: Small tree or shrub with conical, dense to somewhat open crown

1b. *J. communis* L. var. *depressa* Pursh

Common Names: spreading or prostrate juniper

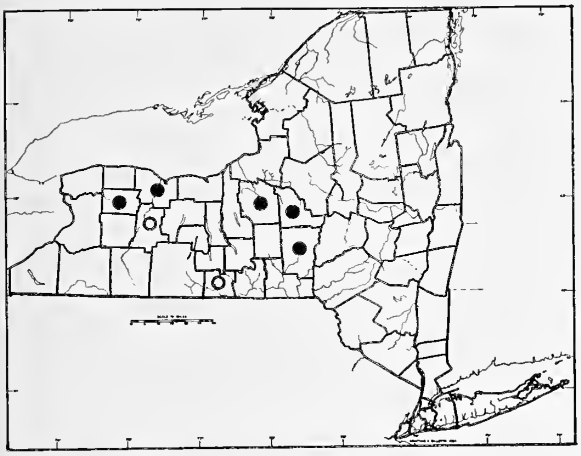
Synonyms: *J. canadensis* Burgsdorf, *J. communis* var. *canadensis* (Burgsdorf) Louden, *J. communis* var. *saxatilis* Pallas, *J. depressa* (Pursh) Raf., *J. sibirica* Burgasdorf

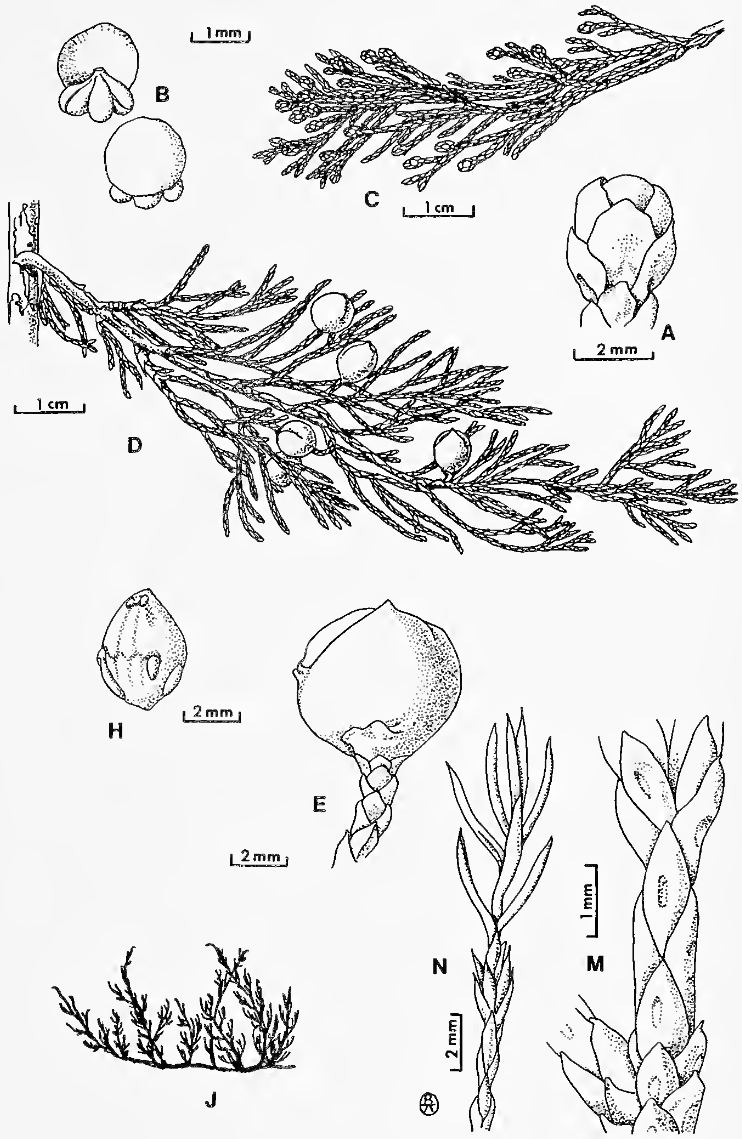
Habitats: Rocky, poor soils of open woodlands, clearings, pastures and ledges

Habit: Decumbent or prostrate with erect branches ascending from the procumbent base. Forming mats up to several meters in diameter, often less than a meter high

Importance: The common juniper is an important part of our ornamental flora, frequently found in rock gardens, as a ground cover, in plantings next to buildings and in dwarf conifer gardens. Numerous horticultural varieties have been bred and sold in

nurseries around the world. In the wild, the berries provide an important food source for birds and mammals. Juniper wood has long been used in Europe, considered an excellent fuel, sometimes used to smoke pork. Because of its durability, it is preferred in some areas for staking vines, and a dye may be made from the twigs. The principal commercial use of juniper has been the extraction of volatile oils from the "berry" for the production of gin. The berries and leaves have served various other purposes, used in gums and varnishes and as a flavoring for beer, jams and spices. Juniper has been used as a coffee substitute in Europe and by Native Americans mostly as a diuretic, but also for a variety of other medicinal treatments, including poultices, treatment of snake bite, intestinal parasites, menstruation, gas, kidney and respiratory problems.





2. *Juniperus horizontalis* Moench

Common Names: creeping juniper, prostrate juniper, creeping savin

Type Description: Moench, Meth., p. 699, 1794

Synonyms: *J. hudsonica* Forbes, *J. prostrata* Pers., *J. repens* Nutt., *J. sabina* var. *horizontalis* Hort., *J. sabina* var. *procumbens* Pursh, *J. sabina* var. *prostrata* Loudon, *J. virginiana* var. *prostrata* (Pers.) Torr., *Sabina horizontalis* (Moench) Rydb., *S. prostrata* (Pers.) Antoine

Origin: Native to North America

Habitats: Often on dolomitic soils in New York State. Elswhere, also on acidic soils in dry or wet sites, mostly on sandy, gravelly shores and dunes, rocky banks, rocky woods, bogs, frequently in fir or alder thickets.

Habit: Small, procumbent or prostrate, often creeping shrub with slender, trailing branches

Pollination: May

Mature Cones Opening: August-October of the 2nd or 3rd season

General Distribution: Newfoundland west to Alaska, south to New Hampshire, southwestern Vermont, northwestern New York, Michigan, northern Illinois, northern Iowa, Minnesota, northern Nebraska and Wyoming

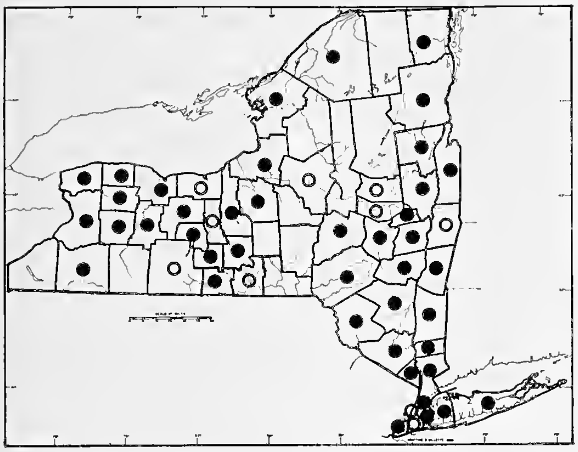
Rarity Status: *Juniperus horizontalis* is listed and ranked E (endangered) under New York State law. It is ranked G5, S1 by the New York State Natural Heritage Program, which means that it is globally secure, but currently not known to be extant at more than five locations in the State.

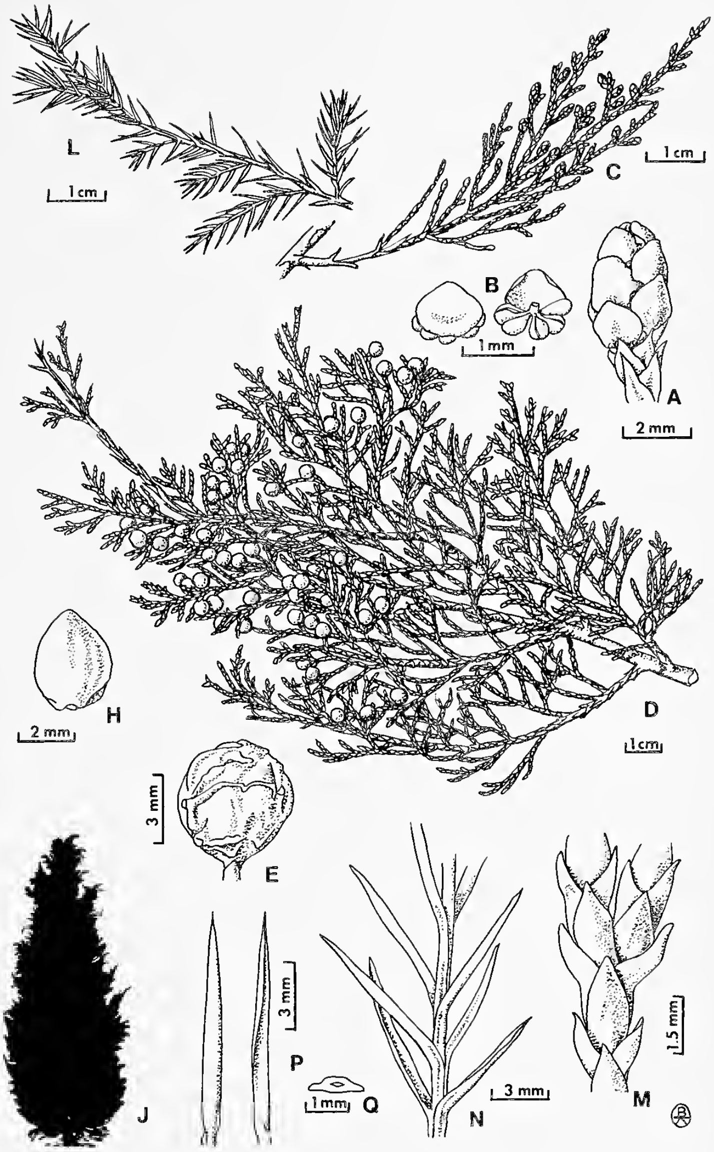
Description: **dioecious**; **female cones** terminal, almost sessile on short, pendulous or recurved lateral branchlets, globose, 6-8

(-10) mm in diameter, green the 1st year, red-purple to dark blue-purple the 2nd year, blue-black the 3rd year, glaucous, glabrous, with 2-4 minute or slightly larger, spreading mucros (or remnants of the cone scales), drying and falling in the 4th to 6th year; **peduncles** 2-3 mm long, covered with 10-14 scale-like, opposite, decussate, appressed, imbricate, ovate, concave leaves; **sterile scales** 2-4; **fertile female cone scales** usually 6; **ovules** 2, vase-shaped with truncate apices, often not fully developing into seeds; **seeds** (1-) 4 (-6) per cone, 3.5-4.5 mm long, about 2.5 mm wide, light to medium brown, roughened by the presence of many resin vesicles; **cotyledons** 2; **male cones** terminal on lateral branchlets, sessile, oblong to subglobose, 2.5-3.5 mm long, 1.5-2.0 mm wide, pale green, becoming brown; **male cone scales** 8, opposite, decussate, about 1.5 mm in diameter, those towards the apex smaller; **lamina** flabellate or ovate-deltoid, about 1.0 mm long, 1.5 mm wide, often with a cusp about 0.3 mm long at the apex; **microsporangia** 3-4 (-6), about 0.5 mm long; **leaves** dimorphic: **juvenile leaves** present in seedlings and to some extent on leading shoots of older plants, opposite, occasionally 3-whorled, divergent, linear-lanceolate or needle-like, 1.5-6.0 mm long, acuminate, with rigid, pungent tips, the bases long-decurrent, **adaxial surface** broadly keeled, covered by the broad, white, longitudinal band of about 4 rows of stomata on each side of the midrib at the base; **adult leaves** opposite, decussate, appressed, sessile, scale-like, narrowly to broadly ovate, broadly keeled, rolled or partially folded around the twig, 1.5-2.0 mm long, 1.0-1.5 mm wide, acute-cuspidate often apiculate or mucronate, green or sometimes blue-green, aromatic, with or without glands on the abaxial surface, becoming hardened and woody in the 3rd year, gradually flaking off in the 4th or 5th year, or falling earlier with the branchlet; **buds** naked, concealed by leaves; **branchlets** concealed by the crowded, imbricate leaves for the 1st three years, about 1 mm in diameter the 1st year, growing about 1 mm in diameter per year thereafter, dark gray or charcoal, occasionally blue-glaucous, roughened by hardened, persistent leaves that gradually fall off, eventually smooth, eventually mostly deciduous; **branches** slender, creeping and long-trailing, branchlets becoming erect or upcurved along one side of the branch; **crown** wide and flat, dense or open; **shrub** usually less than 0.5 meters tall; **root system** fibrous, spreading.

Infraspecific Variation and Hybridization: Creeping juniper is similar to *J. virginiana* except in growth habit, showing great variation in shapes and sizes of both the juvenile and adult leaves. The branches usually have a one-sided appearance, due to their trailing nature and this aspect also helps distinguish the species from *J. virginiana* when dealing with specimens, where the growth habit of the plant is not known. Hybridization with redcedar is known to occur in the northern part of the distribution range of *J. virginiana*.

Importance: More than 70 cultivars have been developed from this species, demonstrating its great value to horticulturalists. It is used as a planting on banks, stone walls, in rock gardens and as a ground cover.





3. *Juniperus virginiana* L.

Common Names: redcedar, eastern redcedar or eastern juniper, savin, red savin, Carolina-cedar, pencil-cedar, Virginia cedar, Virginia juniper, cedar-apple, redcedar juniper, *baton rouge* (redstick)

Type Description: Linnaeus, Species Pl. II, p. 1039, 1753

Synonyms: *J. caroliniana* Michx., *J. sabina* Hook., *Sabina virginiana* (L.) Antoine

Origin: Native to eastern North America

Habitats: Typically scattered individals on loamy soils of sunny slopes, pastures and old fields, sometimes in swamps or on lake shores, but more often on dry, rocky, calcareous hillsides. Frequent on dry, poor soils of the valleys in eastern New York and on the coastal sands of Long Island. Common to infrequent in central and western New York on limestone soils of bluffs, gorges, ravines and alvar vegetation of the flatrock, old fields and pastures, but scarce in the Adirondacks. Often found in places not frequented by fire, growing vigorously on most soils in the Northeast, but New York populations do not compare with vigorous stands found on alluvial soils further south

Habit: A small to medium-sized tree, the crown narrowly to broadly conical, frequently dense, becoming ragged or sculptured with age, trunks with fibrous, light, shredding bark and frequently buttressed at the base

Pollination: February-May

Mature Cones Opening: August-October of the 1st or 2nd year

General Distribution: Southern Maine west through southern parts of Ontario, Michigan, Wisconsin and Minnesota to southeastern South Dakota, south to Florida, Mississippi, northwestern Louisiana and eastern Texas; disjunct in northeastern South Dakota, southwestern North Dakota, northwestern Texas and central Wisconsin

Description: **dioecious** (infrequently **monoecious**); **female cones** borne on short, lateral branchlets or peduncles on the previous year's growth (less often on 2nd-year growth), erect, globose or subglobose, 3-6 (-8) mm in diameter, pale green when young, becoming deep purple or violet when mature, glaucous with a waxy, light blue or gray-blue bloom, fleshy, resinous, sweet, aromatic, persistent 1-2 years; **peduncles** 1-5 mm long, clothed by 8-10 scale-like leaves; **sterile scales** 2-4, at least 2 of them oblong with a shiny, yellow-brown apex; **fertile female cone scales** usually 6; **seeds** 1-2, acute and occasionally apiculate at the apex, light chestnut brown, lustrous, with a relatively small 2-lobed hilum; **cotyledons** 2; **male cones** oblong-cylindrical,

(2) 3-4 mm long, 1.5-2.0 mm wide, green when young, becoming greenish-brown to brown, the apex slightly narrowed; **male cone scales** (10) 12, arranged in decussate pairs on the cone axis, the apical 1 or 2 about half the size of the others; **lamina** orbicular or flabellate, 1.5 mm in diameter, light brown, glabrous; **microsporangia** (3) 4-5 (6), 0.6-0.8 mm long; **peduncle** naked, concealed by the leaves of the branchlets, about 0.7 mm long; **leaves** dimorphic, with juvenile leaves few, appearing on young seedlings and leading shoots of older plants, the transition to adult leaves either gradual or abrupt; **juvenile leaves** whorled or opposite and decussate, long-decurrent, covering the branchlets, subulate or linear-lanceolate, 4-9 mm long, long-acuminate, stiff, pungent, light yellow-green or blue-green, turning rusty, light purple or brown in winter, eglandular, hardening and becoming more rigid, then mostly disarticulating at the point of decurrence in the 4th to 7th year, the remaining bases gradually flaking off, **adaxial surface** concave, often flattened in seedlings or very young plants, bearing 4-5 rows of stomata on each side of the rather flat midrib, the stomata often not evident in young plants, **abaxial surface** convex or rounded-keeled, margins often slightly recurved, lacking stomata except on seedlings or very young plants, which have a flattened abaxial surface with up to 4 rows of stomata sunken on each side of the raised midrib; **adult leaves** opposite, decussate, sessile, crowded and appressed, thereby completely clothing the branchlet, scale-like, ovate, concave, 1.5-2.0 (-3.0) mm long, the exposed portion, 1.0-1.5 mm long, about 1 mm wide, acuminate acute or occasionally obtuse, the apex spreading (later becoming appressed and yellow) and keeled, more rigid than the flattened, sometimes depressed, the basal portion light green, glabrous, entire, aromatic, becoming hard, woody and brown in the 3rd year and finally falling either with the deciduous branchlets after 2-3 years or separately from persistent branchlets after 4-6 years, **abaxial surface** usually bearing a resin gland just below the middle; **buds** naked, minute, inconspicuous, covered by the leaves; **branchlets** horizontal or pendulous, completely covered in the 1st three years by the crowded, appressed scale-like adult leaves or by the decurrent bases of the juvenile leaves, terete, less than 1 mm in diameter the 1st year, to 6 mm in diameter by the 6th year, dark brown to purple or deep red-brown, becoming gray or blackened with age, mostly deciduous; **branches** ascending or spreading in young trees and upper crowns of mature trees, horizontal lower down, short, slender, thicker and heavier only with great age; **bark** thin, 4-7 mm thick, pale brown or red-brown, often grooved, shredding in long, narrow, fibrous strips; **crown** narrowly or broadly conical, dense, often breaking up and becoming ragged with age; **trunk** to 70 (-130) cm in diameter, frequently buttressed toward the base with age; **tree** 1-15 (30) m tall; **root system** deep, extremely windfirm (2n = 22).

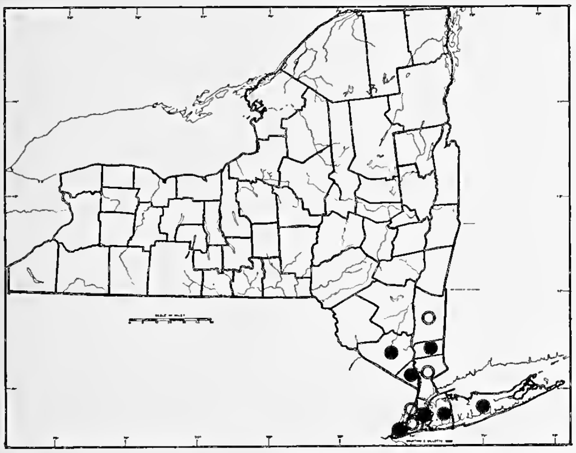
Infraspecific Variation and Hybridization: In coastal or wind-swept situations, under severe environmental stress from salt or ice, redcedars sometimes grow only a few centimeters tall, with long branches forming broad, dense, prostrate mats. This species also shows considerable genetic variation across its eastern North American range, with several infraspecific categories having been described from regions outside New York. Morphological variation is evident in the diameter of branchlets, length, apex and shape of scale-like leaves, leaf terpene content, diameters and lengths of microstrobili, bark color, crown shape and degree to which the branches droop. A tendency towards shorter leaves, smaller cones, thicker ultimate branchlets, more cinnamon-colored bark, a rounder crown and a greater percentage of the terpene, germacrene D, in southeastern coastal populations separates var. *silicicola* (Small) M. Murray, along the Gulf and southern Atlantic coast (Adams, 1986). Intermediate individuals, showing characters of both *J. virginiana* and *J. scopulorum* Sarg. in the west and *J. virginiana* and *J. ashei* Buchholz in the southwestern part of the range of eastern redcedar are probably the result of hybridization and introgression (Fassett, 1944; Hall, 1952). However, there is some terpene evidence pertinent to *J. virginiana*, *J. scopulorum* and their hybrids (Flake et al., 1969) that suggests that intermediates have not been recently established. *Juniperus virginiana* and *J. horizontalis* may have been hybridizing for a long time (Fassett, 1944, 1945; Hall, 1952). More northern populations of *J. virginiana* tend to have characteristics that approach some of those of *J. horizontalis,* such as larger megastrobili, larger and diffently-shaped glands on scale-like leaves and greater numbers of megastrobili with curved peduncles. Variety *ambigens* Fassett, a trailing to semi-erect shrub, is reminiscent of *J. horizontalis* but shares characteristics with *J. virginiana* var. *virginiana* and var. *crebra* Fern. & Grisc. Mature trees of the latter variety tend to be more columnar, with rarely-drooping branchlets, less appressed, narrowly ovate, acute adult scale-like leaves and very shallowly pitted seeds.

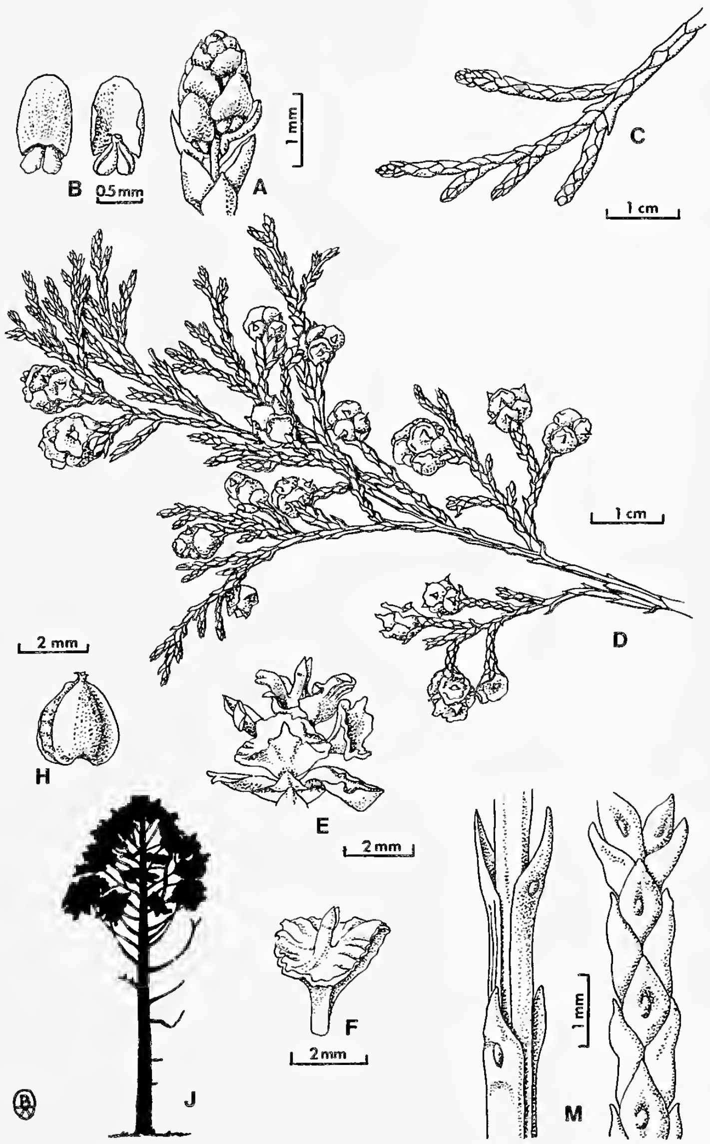
Importance: Some earlier uses for redcedar were boat-building, manufacture of shingles, fence posts, log cabins, pails, woodenware, lining of chests for fragrance and insect protection. Extracts have been used in medicine and perfumes. The manufacture of pencils was economically the most important use, as well as the most destructive to mature trees. Only the straight-grained heartwood was used, and, with the exhaustion of its supply, redcedar was replaced in the industry by incense-cedar [*Calocedrus decumbens* (Torr.) Florin] of western North America. The decay-resistant, light, close-grained, brittle, weak, wood is aromatic, still used for fragrant chests and to produce oil-of-cedar (heartwood oil) for perfumes and components of soaps, polishes and cosmetics. The oil is also used in insecticides and in oil-immersion preparations for microscopes. Native Americans have used extracts of this plant extensively for an assortment of medicinal cures similar to those of *J. communis*, but also for treatment of muscular pains, cramps, mumps, dysentery, headaches, skin rash, arthritis and rheumatism, and as an antiseptic and insect repellent. The bark was used in making canoe parts, mats and dyes. Redcedar is sometimes selected as a Christmas tree, and at least 70 cultivated varieties have been developed to add variety to its frequent use in landscape plantings.

2. CHAMAECYPARIS

Common Names: false-cypress, white-cedar, cedar
Authority: Spach, Hist. Natur. Veget. Phan. XI, p. 329, 1842

Chamaecyparis is genus of seven species with a fairly narrow distribution in Asia and North America. It is closely related to *Cupressus*, from which it is distinguished by its five or fewer seeds per scale, smaller female cones, flattened branchlets and entire leaves. Peltate, globose cones maturing in the 1st year and smaller leaves with exposed connivent margins distinguish it from *Thuja*, and the dry, woody, mature female cones, growth habit and flattened branchlets easily separate it from *Juniperus*. Globose or pitted resin glands may be borne on the abaxial surface of the adult leaves, with both the lateral and facial leaves featuring grooves or depressions whether or not there are glands. Two species of *Chamaecyparis* have relatively limited ranges in northwestern North America. Port Orford-cedar, or Lawson-cypress, *C. lawsoniana* (A. Murr.) Parl., was once a valuable timber tree, but it is currently economically important for ornamental use, with nearly 300 cultivars in the nursery trade. Nootka-cypress or Alaska-cedar [*C. nootkatensis* (D. Don) Spach] was also harvested for timber, and a few horticultural varieties have been developed for the garden. One species, Atlantic white-cedar [*C. thyoides* (L.) BSP.] is a native of eastern North America.





1. *Chamaecyparis thyoides* (L.) BSP.

Common Names: Atlantic white-cedar, southern white-cedar, swamp-cedar, coastal white-cedar, coast-cedar

Type Description: Linnaeus, Species Pl. II, p. 1003, 1753

Synonyms: *Chamaecyparis sphaeroidea* Spach, *Cupressus thyoides* L.

Origin: Native to the eastern, temperate Coastal Plain of the United States

Habitats: Cool, wet swamps and bogs, withstanding long periods of inundation; in pure stands in the northern part of its range, mixed with baldcypress in the southern United States. Of limited distribution in New York, found only in swamps and pine barrens where major stands occur in the southeastern part of the State, especially in the lower Hudson Valley and on Long Island, where it forms "cedar swamps" similar to those in the pine barrens of New Jersey

Habit: Small to large tree with slender ascending, spreading or horizontal branches, forming a narrow conical, often spire-like crown, usually clothed to the ground with live branches, even in the densest forest conditions, the branches eventually dying and deciduous on older trees

Pollination: March-April

Mature Cones Opening: September-October of the 1st season

General Distribution: Along the Atlantic coast from southern Maine to northern South Carolina and western Florida, west along the Gulf of Mexico to eastern Louisiana; disjunct in central South Carolina and eastern Florida

Description: monoecious; female cones solitary, occasionally paired, with only 1 cone fully developing, terminal on short branchlets with scale-like leaves, erect, globose, (3.5-) 5-6 mm in diameter, glabrous, glaucous-blue, dark brown or dark red to purple-brown beneath the bloom, persistent into the 2nd year; **sterile scales** 2, lanceolate, ovate or oblong with a swollen, green apex; **fertile female cone scales** 6, opposite or alternate, peltate, glabrous, apical portion orbicular to flabellate, 3-4 mm in diameter, blue, becoming dark red-brown to purple-brown, the apical mucro prominent, broadly triangular, 0.8-1.0 mm long, acute, yellow-brown; **ovules** 2 per scale, usually only 1 developing into a seed; **seeds** 6, oblong to ovoid, slightly compressed, 2.0-2.5 mm long, 1.5-2.0 mm wide, emarginate or acute, rounded at the base, dark red-brown, dark brown or black, winged on each side, **wings** 2, relatively thick towards the seed, thin at the margins, about 0.5 mm wide, or about half as wide as the seed, dark red-brown; **cotyledons** 2; **male cones** solitary, terminal on short lateral branchlets with scale-like leaves, oblong-cylindric to subglobose, about 2 mm long and 1 mm wide, light brown to brown, deciduous by the 2nd year; **sterile scales** lacking; **peduncle** naked, concealed by the overlapping leaves of the branchlet; **male cone scales** (8-) 10 (-12), opposite, decussate; **lamina** orbicular-flabellate to ovate, about 1 mm in diameter, entire, glabrous; **stalk** about 0.2 mm long; **microsporangia** 2-4, attached adaxially, about 0.3 mm long; **juvenile leaves** present only on seedlings, linear-lanceolate, 4-8 mm long, 1.0-1.5 mm wide, acute, green, glabrous, entire, with 8-10 rows of stomata on each side of the midrib on the abaxial surface, persistent usually 3-4 years; **adult leaves** opposite, decussate, crowded, appressed, scale-like, imbricate, ovate, broadly keeled, adaxially concave, 1-2 mm long, 0.8-1.3 mm wide, acute, glabrous, entire, the margins of opposing lateral leaves meeting below and sometimes connivent above the apex of the facial leaf, aromatic, yellow-green at 1st, becoming dull dark green the first year, turning dark brown, the stomata arranged in 15-20 short, longitudinal rows at the base on each side of the abaxial surface and partially hidden by the overlapping leaves from below, mostly falling with the branchlets in the 2nd year; **leaves of persistent branchlets** attaining lengths of 7 mm including the long, decurrent, appressed base, often with large, prominent, puffy resin glands, these particularly noticeable on the leaf immediately subtending the lateral branchlet, hardening, becoming woody, dark brown or gray-black by the end of the 3rd year, finally separating from the branchlet in the 4th year; **lateral leaves** strongly keeled on the abaxial surface for the length of the leaf, lacking glands; **facial leaves** more flattened, slightly to sharply keeled towards the apex, bending outward and spreading from the middle, with a spherical to elliptical resin gland near the middle of the abaxial surface; **buds** very small, inconspicuous, lacking scales, usually covered by closely overlapping leaves; **branchlets** only slightly flattened, more so on young plants, but together arranged in fan-like, flattened clusters, dull green the first year, brown to gray the 2nd year, dark brown or black-gray the 3rd year, very dark or black thereafter, many lateral branchlets deciduous after the 2nd year, the persistent branchlets roughened from flaking leaves and from scars of the deciduous branchlets in the 3rd year, later becoming smooth except for prominent, raised branchlet scars; **branches** slender, long and ascending, with pendulous lateral branchlets in the upper crown, shortened and more horizontal lower on the tree, persistent, the secondary branches twisted, appearing almost gnarled, dark gray or black; **bark** thin, to 2 cm thick on older trees, red-brown, fissured into flat connected ridges, the ridges often twisting spirally around the trunk, flaking off in long fibrous strips; **crown** narrowly conical, often spire-like, with slender, ascending, spreading or horizontal branches; **trunk** 70-130 cm in diameter, smaller farther north, usually clothed to the ground with live branches, even in dense forest conditions, the branches eventually dying, deciduous on older trees; **tree** 10-25 m tall; **root system** wide- spreading (2n = 22).

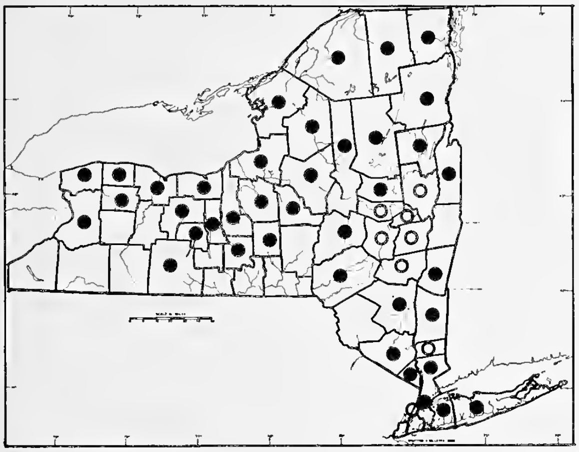
Infraspecific Variation: One botanical variety has been described, and a few cultivars have been developed. Vegetative characters, such as presence or absence of foliar resin glands, provide the limited variation within the species. *Chamaecyparis thyoides* var. *henryae* (Li) Little has been described from Florida and Alabama, with glands only on leaves of the main axes or branchlets. Twisting of the bark on the main trunk of trees is variable, and may not be reliable in distinguishing varieties (Godfrey, 1988).

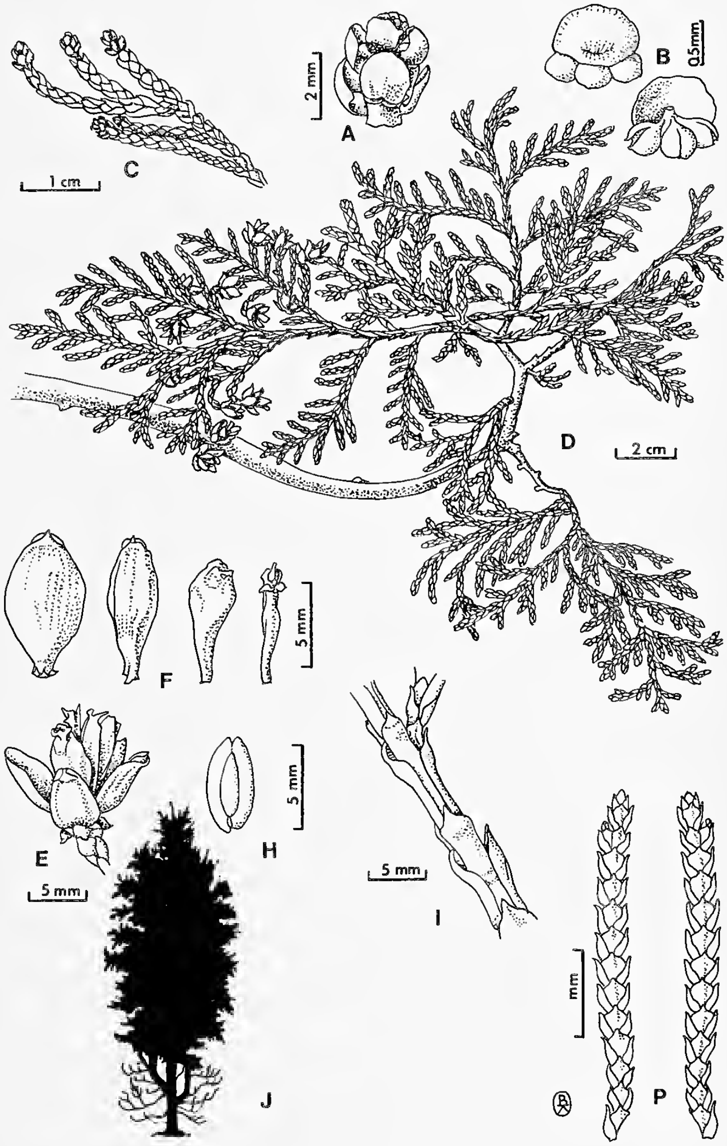
Importance: This tree is of little current economic importance because of its relative scarcity. The light, decay-resistant, insect-repellant qualities of the wood made Atlantic white-cedar useful in the past for telegraph and telephone poles, ice cream packing tubs, shingles, siding, flooring, fence posts, log cabins, railroad ties, piles, piers, boats and wooden tanks. In earlier times the wood was used for water storage for cities and ocean-going vessels, because certain chemical properties inhibited growth of microorganisms. Demand continued for these useful products long after nearly all large, living white-cedars had been harvested, so rot-resistant, durable, preserved logs were then pulled up from the depths of the swamps. The straight, close-grained, uniform-textured wood has a slight fragrance, an ability to hold paint well and not warp or shrink. These are the desirable qualities, while softness and weakness of the wood are obvious disadvantages. The tree is not popular as an ornamental, and only a few cultivated varieties have been developed.

3. THUJA

Common Names: arborvitae, cedar
Authority: Linnaeus, Species Pl. II, p. 1002, 1753

A genus of five species with three native to eastern Asia, one (the economically important *T. plicata* Donn ex D. Don) native to western North America and one (*T. occidentalis*) native to eastern North America. *Thuja plicata* has been lumbered for its valuable, durable wood for telephone poles, shingles and siding. *Thuja occidentalis*, which was originally harvested for these products, is one of the most widely planted ornamental conifers, from hedges to specimen trees to dwarf varieties. Distinctive features of this short-branched tree are thick, short, decussate leaves with exposed margins not meeting, woody, imbricate cones with few scales, and foliage in flattened, feathery sprays.





1. *Thuja occidentalis* L.

Common Names: northern white-cedar, arborvitae, American arborvitae, cedar, eastern arborvitae, white- cedar, swamp-cedar

Type Description: Linnaeus, Species Pl. II, p. 1002, 1753

Origin: A native of North America

Habitats: Usually low moist sites such as swamps, stream courses, borders of ponds and lakes, where it often forms almost impenetrable, pure stands. Sometimes growing on higher, drier ground, but usually thriving on mucky soils near limestone outcroppings. Common in dense stands in swamps and bog margins of northeastern and eastern New York State, less common on drier ground in the Adirondacks, and rare on the Allegheny Plateau

Habit: Medium-sized tree with a narrow, compact, conical crown and stout, buttressed trunk that is often multiple, with 2 or 3 main axes, the short, horizontal branches soon ascending, branchlets in flattened, pendulous, ascending or horizontal sprays

Pollination: April-May

Mature Cones Opening: July-September of the 1st season

General Distribution: Nova Scotia west to southeastern Manitoba, south to southeastern New York, eastern Pennsylvania, Ohio, Michigan, northwestern Indiana, northern Illinois and south in the Appalachians to western North Carolina and eastern Tennessee

Description: **monoecious; female cones** terminal on short lateral branchlets or peduncles, ovoid to short-oblong, (8-) 12 (-15) mm long, 4-6 mm wide and closed when young, to 10 mm wide when open and spreading, green to purple or pink at pollination, becoming red-brown to light brown later darkening, maturing the 1st season, deciduous after the 2nd year; **peduncles** 2-5 (-11) mm long, clothed by (6) 8-10 (12) scale-like, opposite, decussate, imbricate, appressed, ovate, concave leaves; **female cone scales** 8, opposite, decussate, imbricate, woody when mature, red-brown to brown, glabrous or often minutely puberulent at the apex and upper margins, each scale separating slightly at the apex, exposing an inner, rounded or obtuse fold and an outer, hardened dark brown to black mucro, the upper pair of scales sterile, oblong, 7-9 mm long, 2 mm wide, usually not separating or becoming fully developed, the 4 middle scales fertile, ovate to ovate-lanceolate or nearly oblong, concave, 7-9 mm long, 3-5 mm wide, the basal pair sterile, ovate, 3-6 mm long, 2.5-3.0 mm wide; **seeds** 8, borne in pairs at the base of the scale, oblong, 3-5 mm long, 2.5-3.0 mm wide, appearing notched at the apex due to projecting wings on either side of the seed, dark brown, with 4 longitudinal oil vesicles running from 1/4 to the full length of the seed, these projecting above each side of the seed body, **wings** 2, longer than the seed and as wide, pale brown, membraneous, oceasionally minutely puberulent on the upper margins; **cotyledons** 2; **male cones** terminal on lateral branches that are 1-15 mm long, globose to subglobose or short-oblong, inconspicuous, 1.5-2.5 mm long, 1.0-1.5 mm wide, green when young, quickly turning brown then gray-brown, often persisting into the next year; **peduncle** 0.5-1.0 mm long, mostly concealed by leaves at the end of the branchlet; **sterile scales** lacking; **male cone scales** 8, the apical pair often undeveloped, peltate, yellow-brown to light brown; **stalk** about 0.3 mm long; **lamina** flabellate, 0.8-1.0 mm long, about 1.2 mm wide, rounded at the apex, glabrous, entire; **microsporangia** 2-4, attached where the stalk and lamina meet, about 0.5 mm long; **juvenile leaves** present only on young seedlings, awl-shaped or linear; **adult leaves** opposite, decussate, imbricate, scale-like, completely covering the branchlets, flattened facially (facial leaves) or bilaterally (lateral leaves), appressed except for the slightly spreading, free apex, 2.0-3.8 mm long on younger branchlets (to 5 mm on older branchlets, 6.5 mm on leading or rapidly-elongating shoots), about 1.5 mm wide, cuspidate (acuminate on leading or rapidly elongating shoots), glabrous, bright, shining green on the upper surface of the spray, pale or dull yellow-green on the lower surface, aromatic; **facial leaves** usually bearing an obscure, swollen resin gland near the apex of the abaxial surface; **lateral leaves** sharply keeled, eglandular, the upper, exposed margins spreading, not meeting; **buds** naked, minute, yellow, covered by the closely appressed scale-like leaves of the branchlet; **branchlets** flattened, arranged in fan-like clusters or sprays, completely clothed by the green, decurrent bases of the leaves, turning light cinnamon-red with the death and browning of the leaves during their 2nd season, the short, pendulous, lateral branchlets mostly deciduous after the 2nd year; **persistent branchlets** gradually becoming terete and abruptly enlarged at the base, ultimately covered with smooth, lustrous dark orange-brown bark with conspicuous scars left by deciduous lateral branchlets; **branches** short, stout, horizontal, or ascending; **bark** thin, 6-9 mm thick, red-brown, fibrous, shallowly fissured, the anastomosing ridges covered with elongated scales; **crown** conical, narrow, compact, the short horizontal branches soon ascending, with flattened, pendulous, ascending or horizontal, flattened sprays or lateral branchlets; **trunk** buttressed, stout, 35-75 (-100) cm in diameter, sometimes twisted, sometimes divided into 2 or 3 stems; **tree** to 20 m tall, relatively short-lived; **root system** shallowly wide-spreading, the large lateral roots often exposed near the buttressed base of older trees (2n = 22).

Importance: The most important use of arborvitae is as a cultivated ornamental. One of the most frequently cultivated native trees, it is used as a windbreak, next to buildings and for specimen trees. Over 200 cultivated varieties, many of them dwarf, are in the nursery trade. The decay-resistant, fragrant, light, weak, brittle wood has been utilized for fence posts, shingles, rails, railroad ties and poles. Cedar oil extract of arborvitae is used medicinally as a stimulant for heart and uterine muscles and as an irritant and antiseptic. The high concentration of vitamin C in the oil of the leaves and bark cured scurvy in early explorers. The special characteristic of separating along growth rings when pounded made the tree useful for splints in the construction of canoes by Native Americans and early pioneers. The dry shredding outer bark was a favorite source of tinder and native Americans used the twigs as brooms and the wood for bows, baskets, hats and roofings. Native Americans used this species for a variety of ailments, especially respiratory, but also heart and chest pains, gout, rheumatism, dropsy and treatment for worms and warts. The twigs and foliage provide browse for large mammals and the seeds are a food source for birds and small mammals.

APPENDIX

FUNGI ASSOCIATED WITH PLANT SPECIES IN THIS TREATMENT

by J. Kenneth Dean

To be included in this list, a fungus must occur on a host species in this treatment, somewhere in the United States. Abbreviations of state names indicate literature citations only. A single asterisk (*) indicates that the fungus occurs in New York State, and is known to associate (elsewhere) with a host treated here. A double asterisk (**) indicates that a NY specimen with host information has been seen.

OOMYCETES

Phytophthora cinnamomi Rands, on *Abies balsamea* (N.C.), on *Picea abies* (southeastern states, Md., N.C., Va.), on *Pinus resinosa* (Southeastern states, Del., Md.), on *Pinus strobus* (Md., N.C.), on *Pinus sylvestris* (Southeastern states, Md., Va.), *Tsuga canadensis* (N.C.)

Pythium irregulare Buisman, on *Pinus resinosa* (Wisc.)

Pythium ultimum Trow, on *Pinus resinosa* (widespread), on *Pinus strobus* (widespread)

OPHIOSTOMATALES

Ceratocystis coerulescens (Muench) Bakshi, on *Picea glauca* (Ark.), on *Pinus banksiana* (Minn.), on *Pinus resinosa* (Minn.)

Ceratocystis piceaperda (Rumbold) Moreau, on *Picea glauca* (Ark.)

Ceratocystis seticollis R.W. Davidson, associated with bark beetles in *Tsuga canadensis* (N.Y.)

Ophiostoma distortum (R.W. Davidson) De Hoog & Scheffer, on wood, associated with bark beetles, on *Abies balsamea* (N.Y.)

Ophiostoma huntii (Robinson-Jeffrey) De Hoog & Scheffer, on *Pinus strobus* (N.Y.)

Ophiostoma ips (Rumbold) Nannf., on *Picea glauca* (Ark.), on *Pinus banksiana* (Minn.), on *Pinus resinosa* (Minn., Pa.), on *Pinus rigida* (N.J.), on *Pinus strobus* (N.Y.), on *Pinus sylvestris (Mass.)*

Ophiostoma minus (Hedgc.) Syd. & P. Syd., on *Pinus banksiana* (N.C., Va.), on *Pinus resinosa* (N.C., Va.), on *Pinus rigida* (N.C., Va.)

Ophiostoma nigrocarpum (R.W. Davidson) De Hoog, on logs of *Tsuga canadensis* (N.H.)

Ophiostoma olivaceum Mathiesen, on *Picea glauca* (Ark.)

Ophiostoma piliferum (Fr.:Fr.) Syd. & P. Syd., on *Pinus banksiana* (Minn.), on *Pinus rigida* (Pa.), on *Pinus strobus* (Minn.)

Ophiostoma sparsum (R.W. Davidson) De Hoog, on *Picea glauca (Ark.)*

Ophiostoma stenoceras (Robak) Melin & Nannf., on *Pinus strobus* (N.H., N.Y.)

DIAPORTHALES

Cryptosporella thujina Nag Rag & DiCosmo, on *Chamaecyparis thyoides* (N.Y.), on *Juniperus virginiana* (Tex.)

Eutypella leprosa (Pers.:Fr.) Berl., on *Pinus strobus* (Iowa)

Leucostoma kunzei (Fr.:Fr.) Munk, on twigs and stems of *Abies balsamea* (Mich.)

Valsa abietis (Fr.:Fr.) Fr., branch canker of *Abies balsamea* (Maine, Pa.), on dead limbs of *Larix laricina* (N.Y.), of *Tsuga canadensis* (Va., W.Va.)

Valsa ambiens (Pers.:Fr.) Fr., on *Larix laricina* (Mich.)

Valsa cenisia De Not., on dead limbs of *Juniperus virginiana* (Del., Mich., N.J., Okla.)

*Valsa collicula (*M. Wormsk.) Cooke, on limbs and twigs of *Pinus strobus* (N.Y., Pa.), on *Pinus sylvestris* (Pa.)

Valsa friesii (Duby) Fkl., on *Juniperus virginiana* (S.C.)

Valsa pini (Albertini & Schw.) Fr., on *Pinus resinosa* (Iowa), on *Pinus strobus* (widespread), on *Pinus sylvestris* (Iowa), on *Pinus virginiana* (Va.)

SORDARIALES

Bertia moriformis (Tode:Fr.) De Not. var. *latispora* Corlett & J. Krug, on *Abies balsamea* (N.H.), on *Pinus strobus* (N.H.), *Tsuga canadensis* (N.H., N.Y.)
Nitschkia broomeiana (Berk.) Nannf., on *Pinus strobus* (Ga.)

PEZIZALES

Pithya cupressina (Pers.) Fkl., on dead foliage of *Chamaecyparis thyoides* (N.J., N.Y.), on *Juniperus virginiana* (Maryland, Mass., N.C., Okla., Va.)
Plectania melastoma (Sowerby) Fkl., on *Juniperus virginiana* (N.C.)
Plectania nannfeldtii Korf, on *Juniperus virginiana* (N.C.)
Rhizina undulata (Fr.) Fr., seedling blight, on *Picea rubens* (Vt.), on *Pinus banksiana* (Minn.), on *Pinus resinosa* (Md.), on *Tsuga canadensis* (N.Y.)
Scutellinia scutellata (L.:Fr.) Lambotte, on wood of *Tsuga canadensis* (N.C., N.Y.)

AMPHISPHAERIALES

Physalospora abdita (Berk. & Curtis) N. Stevens in Voorhees, on dead limbs of *Juniperus virginiana* (Ga., La.)

LEOTIALES

Ascocalyx abietina (Lagerberg) Schlaepfer, on *Pinus banksiana* (Mich., Minn., N.Y., Wisc.), on *Pinus resinosa* (Maine, Mich., Minn., N.H., N.Y., Wisc.), on *Pinus strobus* (N.Y., Vt.)
Atropellis pinicola Zeller & Goodd., on *Pinus strobus* (Oreg.)
Atropellis piniphila (Weir) Lohman & Cash, on *Pinus banksiana* (S.D.)
Atropellis tingens Lohman & Cash, on *Pinus banksiana* (N.C., Pa.), on *Pinus resinosa* (N.C., Pa., Va.), on *Pinus strobus* (Va.), on *Pinus sylvestris* (Ohio), on *Pinus virginiana* (Ga.)
Botryotinia fuckeliana (de Bary) Whetzel, on *Picea abies* (N.C.)
Cenangium acicola (Fkl.) Rehm, on *Pinus resinosa* (Ohio), on *Pinus strobus* (Wisc.)
Cenangium atropurpureum Cash & Davidson, on *Pinus rigida* (Md.), on *Pinus sylvestris* (Pa.), on *Pinus virginiana* (Md.)
Cenangium ferruginosum Fr.:Fr., twig blight on *Abies balsamea* (Mich., Pa.), on *Pinus resinosa* (N.Y., Pa.), on *Pinus strobus* (northeastern states, N.Y.), on *Pinus sylvestris* (N.Y., Pa.), on *Pinus virginiana* (Md., Va.)
Chloroscypha cedrina (Cooke) Seaver, on foliage of *Juniperus virginiana* (N.C., N.Y.)
Dasyscyphus ellisianus (Rehm) Sacc., on twigs of *Larix laricina* (N.Y., R.I.), on *Pinus resinosa* (northeastern states), on *Pinus rigida* (eastern states), on *Pinus strobus* (eastern states), on *Pinus sylvestris* (Mass., N.J., Pa., R.I.), on *Pinus virginiana* (Md., Pa., Va.)
Dasyscyphus oblongosporus Hahn & Ayers, on dead limbs of *Larix laricina* (Maine, Mass., Mich., N.Y.)
Dermea balsamea (Peck) Seaver in B.O. Dodge, canker on *Tsuga canadensis* (Ga., Mass.)
Didymascella chamaecyparidis (J.F. Adams) Maire, on foliage of *Chamaecyparis thyoides* (N.J.)
Discohainesia oenotherae (Cooke & Ellis) Nannf., on twigs of *Pinus virginiana* (Va.)
Fabrella tsugae (Farl.) Kirschst., on *Tsuga canadensis* (Mass., N.C., N.H., N.Y., Pa., Wisc.)
Hemiphacidium planum (J.J. Davis) Korf, on *Pinus strobus* (Wisc.)
Hyaloscypha stevensonii (Berk. & Broome) Nannf., on *Pinus strobus* (N.Y.)
Korfia tsugae (Cash & R.W. Davidson) Reid & Cain, needle yellowing of *Tsuga canadensis* (N.C.)
Lachnellula abietis (Karst.) Dennis, on *Picea* sp. (N.Y., Vt.)
Lachnellula agassizii (Berk. & Curtis) Dennis, on wood of *Abies balsamea* (Maine, Mich., Vt.), on *Picea mariana* (Mich., N.Y.), on *Picea rubens* (N.Y., Vt.), on *Pinus strobus* (northeastern and north central states), on *Tsuga canadensis* (N.Y.)
Lachnellula arida (Phill.) Dennis, on wood of *Abies balsamea* (Mich.)
Lachnellula laricis (Cooke) Dharne, on dead limbs of *Larix laricina* (Vt.)
Lachnellula occidentalis (Hahn & Ayers) Dharne, on dead limbs of *Larix laricina* (Ark., N.Y., Pa., Vt.)
Lachnellula resinaria (Cooke & Phill.) Rehm, on *Abies balsamea* (Minn.)
Lachnellula subtilissima (Cooke) Dennis, on bark of *Abies balsamea* (Maine), on dead limbs of *Larix laricina* (Conn., Vt.), on *Picea mariana* (Mich., N.Y.), on *Pinus sylvestris* (Mass.)
Lachnellula willkommii (R. Hartig) Dennis, canker on *Larix laricina* (Maine)

Mollisia fumigata (Ellis & Everh.) Sacc., on *Tsuga canadensis* (N.J.)
Nothophacidium abietinellum (Dearn.) J. Reid & Cain, needle blight of *Abies balsamea* (N.H., N.Y.)
Orbilia xanthostigma (Fr.) Fr., on *Tsuga canadensis* (N.Y.)
Pezicula livida (Berk. & Broome) Rehm, on *Pinus strobus* (Ga., Iowa, Mass., N.C.)
Pezizella minuta Dearn., on needles of *Pinus rigida* (N.C.), of *Pinus virginiana* (N.C.)
Phacidium coniferarum (Hahn) DiCosmo, Nag Rag & Kendrick, on *Pinus strobus* (Maine)
Phacidium infestans Karst., snow blight, on *Abies balsamea* (New England states), on *Picea glauca* (New England states), on *Picea rubens* (New England states), on *Pinus strobus* (northeastern states)
Pragmopora pithya (Fr.) Groves, on *Pinus strobus* (N.Y.)
Sarcotrochila balsameae (J.J. Davis) Korf, needle cast of *Abies balsamea* (New England states, Wisc.)
Sarcotrochila piniperda (Rehm) Korf, on needles and twigs on *Picea* sp. (N.H., Vt., Wisc.)
Tryblidiopsis pinastri (Pers.:Fr.) Karst., on *Abies balsamea* (New England states), on *Picea glauca* (N.H.), on *Pinus strobus* (northeastern states, Pa.)
Tympanis confusa Nyl., on *Pinus strobus* (Conn., N.Y.), on *Pinus virginiana* (Va.)
Tympanis hypopodia Nyl., on blister rust cankers on *Pinus strobus* (Conn., Mass.)
Tympanis laricina (Fkl.) Sacc., on *Abies balsamea* (Maine, N.H., N.Y.), on *Pinus* sp. (N.Y.)
Tympanis neopithya Quellette & Pirozynski, on *Pinus* sp. (Mich., N.C.)
Tympanis truncatula (Pers.:Fr.) Rehm, on limbs of *Abies balsamea* (Mich., N.H., N.Y.)

RHYTISMATALES

Bifusella linearis (Peck) Hoehn., on *Pinus strobus* (Widespread)
Coccomyces petersii (Berk. & Curtis) M.A. Sherwood, on bark and twigs of *Juniperus communis* (Ala.), of *Juniperus virginiana* (Ala., Ga., Mass., N.C., N.Y.)
Coccomyces strobi J. Reid & Cain, on *Pinus strobus* (Conn., Mass., Minn., N.C., N.H., N.J., N.Y., Wisc.)
Cyclaneusma minus (Butin) DiCosmo, Peredo & Minter, on *Pinus sylvestris* (Mass.)
Cyclaneusma niveum (Pers.:Fr.) DiCosmo, Perado & Minter, on *Pinus sylvestris* (Ga., Mass., Mich., Pa., Wisc.)
Davisomycella ampla (J.J. Davis) Darker, on *Pinus banksiana* Great Lakes states)
Isthmiella faullii (Darker) Darker, needle cast on *Abies balsamea* (Maine, Mich., N.H., N.Y., Vt., Wisc.)
Lirula macrospora (R. Hartig) Darker, needle blight, tar spot, on *Picea glauca* (Ark., N.D.), on *Picea mariana* (Ark.) on *Picea rubens* (N.Y., Vt.)
Lirula mirabilis (Darker) Darker, needle cast of *Abies balsamea* (Mich., Wisc.)
Lirula nervata (Darker) Darker, needle cast of *Abies balsamea* (Maine, N.H., Vt.)
Lophodermium durilabrum Darker, on *Pinus strobus* (Wisc.)
Lophodermium juniperinum (Fr.) De Not. f. *cupressi-thyoidis* Sacc., on foliage of *Chamaecyparis thyoides* (N.J.), on *Juniperus communis* (widespread), on *Juniperus virginiana* (Mass., N.Y., Wash., Wisc.)
Lophiodermium lacerum Darker, secondary needle cast of *Abies balsamea* (N.H., N.Y., Pa., Vt.)
Lophodermium nitens Darker, on *Pinus strobus* (eastern states, Ga., Mich., N.C., Wash., Wisc.)
Lophodermium piceae (Fkl.) Hoehn., needle cast, tar spot, on *Picea abies* (Mass., Mich.), on *Picea glauca* (Mich.), on *Picea mariana* (Maine)
Lophodermium pinastri (Schrad.:Fr.) Chev., on *Pinus banksiana* (Great Lakes states, Idaho), on *Pinus resinosa* (widespread), on *Pinus rigida* (widespread), on *Pinus strobus* (widespread), on *Pinus sylvestris* (widespread), on *Pinus virginiana* (Ga., Md., Pa., Va.)
Lophodermium staleyi Minter, on *Pinus sylvestris* (Oreg.)
Lophodermium seditiosum Minter, Staley & Millar, on *Pinus resinosa* (Ind., Mich., Oreg., Wash.), on *Pinus virginiana* (Ind., Mich., Oreg., Wash.)
Lophomerum autumnale (Darker) Magasi in Quellette & Magasi, needle cast of *Abies balsamea* (Mich.)
Meloderma desmazieresii (Duby) Darker, on *Pinus resinosa* (N.Y.), on *Pinus rigida* (northeastern states, N.Y.), on *Pinus strobus* (eastern states, Ga., N.C., Wisc.)
Naemacyclus fimbriatus (Schw.) DiCosmo, Peredo & Minter, on cone scales of *Pinus resinosa* (Mass.)
Ploioderma hedgcockii (Dearn.) Darker, on *Pinus rigida* (N.C.), on *Pinus virginiana* (southeastern states, Miss., Tenn.)
Ploioderma lethale (Dearn.) Darker, on *Pinus resinosa* (N.Y.), on *Pinus rigida* (eastern states, Miss., Pa., W.Va., on *Pinus virginiana* (southeastern states, Tenn., Va.)
Propolis leonis (Tul. & C. Tul.) Rehm, on bark and cones of *Pinus sylvestris* (Ga.)
Propolis rhodoleuca (Sommerf.) Fr., on *Pinus strobus* (Ga.)

Therrya fuckelii (Rehm) Kujala, on dead limbs of *Pinus resinosa* (Mich., N.H.)
Therrya pini (Albertini & Schw.) Hoehn., on limbs and twigs of *Pinus strobus* (eastern states, Ga., Mich.)

DIATRYPALES

Diatrypella favacea (Fr.:Fr.) De Not, on *Juniperus virginiana* (Ga.)

XYLARIALES

Rosellinia herpotrichioides Hepting & R.W. Davidson, needle and twig blight of *Tsuga canadensis* (N.C.)
Rosellinia deerata (Curtis & Ellis) Sacc., on wood of *Juniperus virginiana* (N.J.)
Xylaria cornu-damae (Schw.) Fr., on *Pinus strobus* (N.C.)
Xylaria curta Fr., on wood of *Tsuga canadensis* (Maine)
Xylaria hypoxylon (L.:Fr.) Grev., on wood of *Tsuga canadensis* (N.C., S.C.)
Xylaria longipes Nitschke, on logs of *Tsuga canadensis* (N.C.)

CORYNELIALES

Caliciopsis thujina (Ellis & Everh.) Fitzp., on dead foliage of *Chamaecyparis thyoides* (N.J.)
Caliciopsis nigra (Schrad.:Fr.) Fitzp., on limbs associated with galls on *Juniperus virginiana* (N.Y.)
Caliciopsis pinea Peck, on *Pinus rigida* (N.C., N.J.), on *Pinus strobus* (N.C., N.Y.), on *Pinus virginiana* (N.C., Va.), *Tsuga canadensis* (Pa.)

HYPOCREALES

Hypocrea ceramica Ellis & Everh., on *Juniperus virginiana* (N.C.)
Nectria fuckeliana Booth, on bark of *Abies balsamea* (Maine, Mich.)
Nectria thujana (Rehm) Sacc., on dead foliage of *Chamaecyparis thyoides* (N.J.)
Nectria truncata Ellis, on dead bark of *Chamaecyparis thyoides* (N.J.)
Scoleconectria cucurbitula (Tode:Fr.) C. Booth, canker on *Abies balsamea* (widespread), on *Picea mariana* (N.Y.), on *Pinus banksiana* (Wisc.), on *Pinus resinosa* (Wisc.), on *Pinus rigida* (N.J.), on *Pinus sylvestris* (Iowa), on *Pinus virginiana* (Md., Va.)
Thyronectria balsamea (Cooke & Peck) Seeler, bark canker on *Abies balsamea* (Mich., Minn., N.H., N.Y., Pa., Vt.), on *Pinus strobus* (N.Y.)

TRICHOSPHAERIALES

Trichosphaeria cupressina Syd., on dead foliage of *Chamaecyparis thyoides* (N.J.)
Chaetosphaeria parvicapsa (Cooke) Sacc., on *Juniperus virginiana* (Ga.)

DOTHIDEALES

Asterina cupressina (Rehm) Cooke, on foliage of *Juniperus communis* (Wisc.)
Asterina sp., on needles of *Abies balsamea* (N.Y.)
Botryosphaeria dothidea (Moug.:Fr.) Ces. & De Not., on *Pinus strobus* (Ga.)
Botryosphaeria obtusa (Schw.) Shoemaker, on *Chamaecyparis thyoides* (N.J.), on *Juniperus virginiana* (Md., N.J., N.Y., Va.), on *Pinus strobus* (N.Y.)
Botryosphaeria quercuum (Schw.) Sacc., on *Chamaecyparis thyoides* (N.J.), on *Juniperus virginiana* (N.Y.)
Botryosphaeria ribis Gross. & Duggar, on twigs of *Chamaecyparis thyoides* (Ga., S.C.), on *Juniperus virginiana* (Ala., N.J., Va.), on *Picea abies* (Ill.), on *Pinus strobus* (Ga.)
Capnodium pini Berk. & Curtis, black mildew on needles of *Pinus strobus* (widespread)
Coccodothis sphaeroidea (Cooke) Theiss. & Syd., on foliage of *Juniperus virginiana* (Ga., La., N.C., S.C.)
Cucurbidothis pithyophila (Schmidt & Kunze:Fr.) Petr., on *Pinus strobus* (Mich., Wash.)
Delphinella balsameae (A.M. Waterman) E. Mueller in E. Mueller & Arx, needle blight on *Abies balsamea* (New England states)

Delphinella peckii (Lindau) Barr, on cone scales of *Tsuga canadensis* (N.Y.)
Dimerium balsamicola (Peck) Shoemaker, on *Abies balsamea* (northeastern states), on *Picea* sp. (northeastern states)
Dothidea acerva Barr, on Juniperus communis (Mass., N.H.)
Glonium stellatum Muehlenberg, on *Tsuga canadensis* (N.C.)
Herpotrichia juniperi (Duby) Petr., brown felt blight, on *Juniperus communis* (western states), on *Picea abies* (Colorado, Oreg., Wyom.)
Hysterium macrosporum Gerard in Peck, on *Pinus* sp. (N.Y.)
Hysterographium flexuosum (Schw.:Fr.) Sacc., on *Pinus virginiana* (N.J.)
Kirschsteiniothelia thujina (Peck) Hawksworth, on wood of *Abies balsamea* (Maine)
Mycosphaerella dearnessii Barr, on *Pinus resinosa* (Wisc.), on *Pinus rigida* (La., N.C., Tenn.), on *Pinus strobus* (N.C.), on *Pinus sylvestris* (Iowa, Kans., Kentucky, Minn., Mo., Ohio, Wisc.), on *Pinus virginiana* (Ga., N.C.)
Mycosphaerella juniperina (Ellis) Tomilin, on foliage of *Juniperus communis* (Iowa), on *Juniperus virginiana* (Md., Okla.)
Mytilinidion decipiens (Karst.) Sacc., on bark of *Juniperus virginiana* (Kans., Miss., N.C., N.J.)
Mytilinidion mytilinellum (Fr.) Zogg, on *Pinus strobus* (Mich.)
Mytilinidion tortile (Schw.) Ellis & Everh., on *Juniperus virginiana* (Ga.)
Neopeckia coulteri (Peck) Sacc. in Peck, brown felt blight on *Pinus strobus* (Mont.)
Phaeocryptopus nudus (Peck) Petr., needle cast, black mildew on *Abies balsamea* (Maine, N.C., N.Y., Wisc.), on *Tsuga canadensis* (N.C., N.Y.)
Phaeocryptopus pinastri (Ellis & Sacc.) Petr., on *Pinus rigida* (Ga., N.J.)
Pododimeria gelatinosa Luttrell & Barr, on *Juniperus virginiana* (Va.)
Pododimeria juniperi (Batista) Luttrell & Barr, on *Juniperus virginiana* (Ga., N.J.)
Maurodothina farrae Pirozynski & Shoemaker, black mildew on living needles of *Abies balsamea* (N.Y.)
Rasutoria tsugae (Dearn.) Barr, on needles of *Tsuga canadensis* (Conn., N.H., Tenn., W.Va.)
Rebentischia massalongii (Mont.) Sacc., on limbs of *Abies balsamea* (Maine)
Scorias spongiosa (Schw.:Fr.) Fr., snow mold on *Pinus strobus* (Ind.)
Seynesiella exigua Barr, on dead leaves of *Juniperus communis* (Maine, N.H., Vt.)
Seynesiella juniperi (Desmaz.) G. Arnaud, on foliage of *Juniperus virginiana* (N.J.)
Strigopodia resinae (Sacc. & Bres.) Hughes, on *Abies balsamea* (N.H.), on *Picea rubens* (Maine)

PATELLARIALES

Holmiella sabina (De Not) Petrini, Samuels, & E. Mueller, on wood of *Juniperus communis* (Mont.), on *Juniperus virginiana* (Kan., N.Y.)
Rhizodiscina lignyota (Fr.:Fr.) Hafellner, on *Juniperus virginiana* (Ga.)
Murangium sequoiae (Plowr. ex Phill.) Seaver, on bark of *Juniperus virginiana* (S.C.)

UREDINALES

Chrysomyxa arctostaphyli Dietel, on *Picea abies* (Mont., Wash.), on *Picea glauca* (Wash., Wyom.)
Chrysomyxa empetri J. Schroet. ex Cummins, on *Picea rubens* (Maine)
Chrysomyxa ledi de Bary, on *Picea glauca* (S.D.), on *Picea mariana* (widespread), on *Picea rubens* (Maine)
Chrysomyxa ledi de Bary var. *cassandrae* (Peck & Clinton) Savile, on *Picea glauca* (Minn., Wisc.), on *Picea mariana* (widespread), on *Picea rubens* (Mich., N.Y.)
Chrysomyxa ledicola Lagerh., on *Picea glauca* (Ark., Minn.), on *Picea mariana* (widespread), on *Picea rubens* (N.H., N.Y.)
Chrysomyxa pirolata Wint. in Rabenh., on *Picea glauca* (Ark., Maine, Mich.), on *Picea mariana* (Ark., Mass., N.H., Pa.), on *Picea rubens* (Maine, N.Y., Pa., Vt.)
Chrysomyxa roanensis (Arth.) Arth., on *Picea rubens* (Tenn.)
Chrysomyxa weirii H. Jacks., on *Picea glauca* (S.D.), on *Picea rubens* (Tenn.)
Coleosporium asterum (Dietel) Syd. & P. Syd., on *Pinus banksiana* (widespread), on *Pinus resinosa* (northeastern states, Ill., Minn.), on *Pinus rigida* (eastern states, Maryland, Mass., N.C., Ohio, Pa.), on *Pinus sylvestris* (N.J.), on *Pinus virginiana* (Ga., Pa., Tenn., Va.)
Coleosporium delicatulum Arth., on *Pinus resinosa* (widespread), on *Pinus rigida* (widespread)
Coleosporium helianthi (Schw.) Arth., on *Pinus rigida* (N.C.), on *Pinus virginiana* (eastern states, southeastern states, N.C., Ohio, S.C.)
Coleosporium inconspicuum Arth., on *Pinus virginiana* (southeastern states, N.C., Ohio, Tenn.)

Coleosporium ipomoeae (Schw.) Burrill, on *Pinus rigida* (eastern states, Ala.)
Coleosporium laciniariae Arth., on *Pinus rigida* (eastern states)
Coleosporium pinicola Arth., on *Pinus rigida* (Mass.), on *Pinus virginiana* (widespread)
Coleosporium tussilaginis (Pers.) Lev. in C. d'Orb., on *Pinus resinosa* (Mich., N.H., N.Y.), on *Pinus rigida* (eastern states, Ohio), on *Pinus sylvestris* (N.Y., Wisc.)
Coleosporium vernoniae Berk. & Curtis in Berk., on *Pinus rigida* (widespread), on *Pinus sylvestris* (Ohio)
Cronartium coleosporioides Arth., on *Pinus banksiana* (Mich.), on *Pinus sylvestris* (S.D.)
Cronartium comandrae Peck, on *Pinus resinosa* (Conn.), on *Pinus rigida* (Conn., N.J.), on *Pinus sylvestris* (eastern states)
Cronartium comptoniae Arth., on *Pinus banksiana* (northeastern states, Minn., Wisc.), on *Pinus resinosa* (northeastern states, Minn.), on *Pinus rigida* (northeastern states), on *Pinus sylvestris* (northeastern states, central states, Wisc.), on *Pinus virginiana* (Md., N.C., N.J., Pa.)
Cronartium quercuum (Berk.) Miyabe ex Shirai, on *Pinus banksiana* (Conn., Mich., Minn., Wisc.), on *Pinus resinosa* (Minn., N.J.), on *Pinus rigida* (northeastern states, Kentucky, Tenn.), on *Pinus sylvestris* (Mich., N.C.), on *Pinus virginiana* (widespread)
Cronartium quercuum (Berk.) Miyabe ex Shirai f. sp. *banksianae* Burdsall & G. Snow, on *Pinus banksiana* (Minn., Wisc.)
Cronartium quercuum (Berk.) Miyabe ex Shirai f. sp. *virginianae* Burdsall & G. Snow, on *Pinus virginiana* (Va.)
Cronartium ribicola J.C. Fisch., on *Pinus resinosa* (Minn.), on *Pinus strobus* (eastern states, Great Lake states, N.C., Tenn., Va., Wash.)
Endocronartium harknessii (J.P. Moore) Hiratsuka, on *Pinus banksiana* (Idaho, Mich., Minn.), on *Pinus sylvestris* (widespread)
Gymnosporangium asiaticum Miyabe ex G. Yamada, on *Juniperus virginiana* (Wisc.)
Gymnosporangium bermudianum Earle in Seym. & Earle, on *Juniperus virginiana* (Ala., Fla., La., Miss.)
Gymnosporangium clavariiforme (Wulfen in Jacq.:Pers.) DC., on *Juniperus communis* (western states)
Gymnosporangium clavipes (Cooke & Peck) Cooke & Peck in Peck, on *Juniperus communis* (widespread)
Gymnosporangium cornutum Arth. ex F. Kern, on *Juniperus communis* (western states, Maine, Mich.)
Gymnosporangium davisii F. Kern, on *Juniperus communis* (Maine, Wisc.), on *Juniperus virginiana* (Fla.)
Gymnosporangium effusum F. Kern, on *Juniperus virginiana* (Md., N.J., N.Y., S.C., Va.)
Gymnosporangium exiguum F. Kern, on *Juniperus virginiana* (Texas)
Gymnosporangium exterum Arth. & Kern in Arth., on *Juniperus virginiana* (Ky., Va.)
Gymnosporangium floriforme Thaxt. in F. Kern, on *Juniperus virginiana* (southeastern states, Okla., Texas)
Gymnosporangium globosum (Farl.) Farl., on *Juniperus virginiana* (widespread)
Gymnosporangium juniperi-virginae Schw., on *Juniperus horizontalis* (Ill.), on *Juniperus virginiana* (widespread)
Gymnosporangium nelsonii Arth., on *Juniperus virginiana* (N.Y.)
Gymnosporangium nidus-avis Thaxt., on *Juniperus virginiana* (Conn., Ga., Mass., Miss., N.C., Okla., S.D.)
Gymnosporangium trachysorum F. Kern ex Arth., on *Juniperus virginiana* (La., Miss., S.C.)
Melampsora abieti-capraearum Tub., on *Abies balsamea* (widespread)
Melampsora abietis-canadensis C.A. Ludw. ex Arth., on *Tsuga canadensis* (northeasren states, northcentral states, N.C., Va., Wisc.)
Melampsora farlowii (Arth.) J.J. Davis, on *Tsuga canadensis* (eastern states, N.C., Va., Wisc.)
Melampsora medusae Thuem., on *Larix laricina* (widespread)
Melampsora paradoxa Dietel & Holw. in Dietel, on *Larix laricina* (widespread)
Melampsorella caryophyllacearum J. Schroet., on *Abies balsamea* (widespread), on *Picea abies* (Idaho, Mont., Wash., Wyom.), on *Picea glauca* (widespread), on *Picea rubens* (Maine, N.Y.)
Melampsoridium betulinum Kleb., on *Larix laricina* (Conn., Wisc.)
Milesina fructuosa (Faull) Hiratsuka, on *Abies balsamea* (Maine, N.H., N.Y.)
Milesina marginalis (Faull & Watson) Faull & Watson ex Hiratsuka, on *Abies balsamea* (Mass., N.H., N.Y.)
Milesina pycnograndis (Arth.) Hiratsuka, on *Abies balsamea* (Maine, N.H., N.Y.)
Peridermium cerebrum Peck, on *Pinus rigida* (N.Y.)
Peridermium coloradense (Dietel) Arth. & F. Kern, on *Picea glauca* (Ark.)
Peridermium comptoniae Orton & J.F. Adams, on *Pinus sylvestris* (Conn.)
Peridermium harknessii J.P. Moore, on *Pinus sylvestris* (S.D.)
Peridermium stalactiforme Arth. & F. Kern, on *Pinus banksiana* (Minn.)
Pucciniastrum arcticum Tranzschel, on *Picea glauca* (widespread)
Pucciniastrum epilobii G. Otth, on *Abies balsamea* (Mich., N.Y., Vt., Wisc.)
Pucciniastrum goeppertianum (Kuehn) Kleb., on *Abies balsamea* (Maine, Pa., Wisc.)
Pucciniastrum hydrangeae (Magnus) Arth., on *Tsuga canadensis* (Ind., Md., N.C., Pa., Tenn., Va., W.Va.)

Pucciniastrum pustulatum Dietel in Engl. & Prantl, on *Abies balsamea* (Mich., Minn., N.Y., Wisc.)
Pucciniastrum vaccinii (G. Wint.) Jorst., on *Tsuga canadensis* (eastern states, Ga., Ind., Wisc.)
Uredinopsis americana P. Syd. & Syd., on *Abies balsamea* (widespread)
Uredinopsis osmundae Magnus, on *Abies balsamea* (widespread)
Uredinopsis phegopteris Arth., on *Abies balsamea* (Wisc.)
Uredinopsis struthiopteris Stoermer ex Dietel, on *Abies balsamea* (Mich.)

TULASNELLALES

Tulasnella fuscoviolacea Bres., on bark of *Abies balsamea* (N.H.), on *Picea rubens* (N.H.), on *Picea* sp. (N.Y.)
Oliveonia subviolacea (Peck) Larsen, on bark of *Pinus strobus* (Mass.), of *Tsuga canadensis* (N.C., N.Y.)
Uthatobasidium fusisporum (J. Schroet.) Donk, on *Pinus rigida* (Pa.)

TREMELLALES

Exidiopsis calcea (Pers.) K. Wells, on *Juniperus virginiana* (Fla.), on *Picea glauca* (Ark.), on *Picea mariana* (Minn.), on *Pinus rigida* (N.H.), on *Tsuga canadensis* (N.Y.)
Exidiopsis podlachica (Bres.) Ervin, on fallen logs of *Pinus strobus* (Mass.)
Heterochaete shearii (Burt) Burt, on dead limbs of *Juniperus virginiana* (La.)
Protodontia piceicola (Bourd.) G.W. Martin, on *Tsuga canadensis* (Wisc.)
Pseudohydnum gelatinosum (Scop.:Fr.) Karst., on *Tsuga canadensis* (N.C.)
Sebacina epigaea (Berk. & Broome) Bourd. & Galzin, on wood of *Juniperus virginiana* (Ga., La.)
Sebacina incrustans (Pers.:Fr.) Tul., at base of living trees of *Juniperus virginiana* (Fla.)

AURICULARIALES

Auricularia auricula (L.:Fr.) Underw., on *Abies balsamea* (Minn.), on *Picea glauca* (Minn.), on *Picea rubens* (Conn., Maine, N.H., N.Y.)
Platygloea acanthophysa Burdsall, on wood of *Tsuga canadensis* (Wisc.)
Platygloea unispora Olive, on limbs of *Chamaecyparis thyoides* (Ga.)

DACRYMYCETALES

Arrhydtidia involuta (Schw.) Coker, on *Pinus rigida* (N.Y.), on *Tsuga canadensis* (W.Va.)
Calocera cornea (Batsch:Fr.) Fr., on *Juniperus virginiana* (Ind.), on *Tsuga canadensis* (Mass.)
Cerinomyces pallidus G.W. Martin, on *Tsuga canadensis* (Wisc.)
Dacrymyces minor Peck, on wood of *Pinus strobus* (N.Y.)
Dacrymyces minutus (Olive) McNabb, on wood of *Tsuga canadensis* (N.C.)
Dacrymyces tortus (Willd.:Fr.) Fr., on *Picea glauca* (N.Y.)
Dacryopinax spathularia (Schw.:Fr.) G.W. Martin, on wood of *Tsuga canadensis* (N.Y.)

APHYLLOPHORALES

Acanthophysium fennicum (Laurila) Parmasto, on limbs and twigs of *Picea rubens* (N.H., N.Y., Vt.)
Acanthophysium lividocaeruleum (Karst.) Boudin, on *Picea glauca* (Ark.)
Acanthophysium weirii (Burt) Parmasto, on bark of *Larix laricina* (Mich.)
Albatrellus caeruleoporus (Peck) Pouzar, in *Tsuga canadensis* duff**
Albatrellus confluens (Alb. & Schw.:Fr.) Kotl. & Pouzar, on ground in *Tsuga canadensis* stand **
Aleurobotrys botryosus (Burt) Boidin et al., on bark of *Juniperus virginiana* (La.)
Aleurocystidiellum subcruentatum (Berk. & Curtis) Lemke, on limbs and trunks of *Picea rubens* (N.H., N.Y.)
Aleurodiscus abietis H. Jacks. & Lemke in Lemke, on living and dead limbs of *Abies balsamea* (N.Y., Vt.)
Aleurodiscus amorphus (Pers.:Fr.) Schroet. in Cohn, on weak, injured or recently dead trees of *Abies balsamea* (Conn., Maine, Mich., Minn., N.H., N.Y., Vt.), on *Larix laricina* (Minn.), on *Picea mariana* (N.Y.), on *Pinus strobus* (widespread), on *Tsuga canadensis* (northeastern states)
Aleurodiscus farlowii Burt, on *Tsuga canadensis* (northeastern states)

Aleurodiscus penicillatus Burt, on *Picea rubens* (N.H.), on *Tsuga canadensis* (Vt.)
Aleurodiscus piceinus Lyon & Lemke in Lemke, on dead stems and twigs of *Picea rubens* (N.H., Vt.)
Amphinema byssoides (Pers.:Fr.) Eriksson, on *Picea glauca* (Ark.), on *Pinus sylvestris* (Ohio), on *Tsuga canadensis* (N.Y.)
Amylocorticium canadense (Burt) Eriksson & Weresub in Weresub, on *Tsuga canadensis* (N.Y.)
Amylocorticium subincarnatum (Peck) Pouzar, on *Picea glauca* (Minn.)
Amylocystis lapponica (Romell) Sing., comb. inval., on *Picea glauca* (N.H.), on *Picea rubens* (N.H.)
Amylostereum chailletii (Pers.:Fr.) Boidin, on *Abies balsamea* (N.H., N.Y.), on *Chamaecyparis thyoides* (N.J.), on *Juniperus virginiana* (Conn., N.Y.), on *Picea glauca* (Ark.), on *Picea rubens* (N.Y.), on *Pinus sylvestris* (Conn.), on *Tsuga canadensis* (N.Y., Vt.)
Antrodia albida (Fr.:Fr.) Donk, on *Juniperus virginiana* (Mo., Pa., Va.), on *Picea glauca* (Ark.), on *Picea rubens* (Conn., Maine, N.H., N.Y.), on *Tsuga canadensis* (N.Y.)
Antrodia albobrunnea (Romell) Ryv., on *Picea glauca* (Ark.)
Antrodia heteromorpha (Fr.:Fr.) Donk, on *Abies balsamea* (New England states), on *Juniperus virginiana* (N.C.), on *Picea rubens* (Conn., Maine, N.H., N.Y.), on *Tsuga canadensis* (Maine, N.Y., Va.)
Antrodia juniperina (Murr.) Niemela & Ryv., on *Juniperus virginiana* (Fla.)
Antrodia odora (Peck in Sacc.) Gilb. & Ryv., on *Picea glauca* (Ark.)
Antrodia radiculosa (Peck) Gilb. & Ryv., on *Picea abies* **, on *Tsuga canadensis* (N.Y.)
Antrodia serialis (Fr.:Fr.) Donk, on *Abies balsamea* **, on *Picea glauca* (Ark.), on *Picea mariana* (Minn.), on *Picea rubens* (New England, Pa.), on *Pinus resinosa* (Minn.), on *Pinus rigida* **, on *Pinus virginiana* (widespread), on *Tsuga canadensis* (Maine, N.Y., Pa.)
Antrodia sinuosa (Fr.:Fr.) Karst., on *Abies balsamea* (New England states), on *Picea glauca* (Ark.), on *Picea mariana* (Great Lake states), on *Picea rubens* (New England states, **), on *Tsuga canadensis* (N.Y.)
Antrodia sordida Ryv. & Gilb., on *Picea mariana* (Minn.), on *Picea rubens* (N.H.), on *Pinus* sp.**
Antrodia vaillantii (Fr.) Ryv., on spruce boards **, on *Pinus* sp. **, on *Tsuga canadensis* (widespread)
Antrodia variiformis (Peck) Donk, on *Picea rubens* (New England states, N.Y.)
Antrodia xantha (Fr.:Fr.) Ryv., on *Abies balsamea* (Minn.), on *Picea glauca* (Ark.), on *Picea rubens* (Maine), on charred log of *Pinus* sp. **
Antrodiella overholtsii Ryv. & Gilb., on *Picea glauca* (Minn.), on conifer **
Asterodon ferruginosum Pat., on *Picea glauca* (Ark.), on *Picea rubens* (Conn., Maine, N.H., N.Y.)
Athelia laxa (Burt) Juelich, on *Tsuga canadensis* (Conn., Pa., Va.)
Athelia newhoffi (Bres.) Donk, on *Picea glauca* (Ark.)
Auriporia aurea (Peck) Ryv., on *Tsuga canadensis* (N.Y.)
Auriscalpium vulgare S.F. Gray, on cones of on *Pinus rigida* (Mass.), on *Pinus sylvestris* (Kans.)
Basidioradulum radula (Fr.:Fr.) Nobles, on *Picea* sp. (N.Y.), on *Tsuga canadensis* (N.Y.)
Bjerkandera adusta (Willd.:Fr.) Karst., on *Juniperus virginiana* (widespread), on *Picea glauca* (Minn.), on *Tsuga canadensis* (S.C.)
Bondarzewia berkeleyi (Fr.) Bondartsev & Singer, on *Juniperus virginiana* (N.C.), on *Pinus strobus* (Minn.), on *Tsuga canadensis* **
Boreostereum radiatum (Peck) Parmasto, on *Picea glauca* (Ariz., Minn.), on *Picea mariana* (Minn., N.Y.), on *Picea rubens* (Maine), on *Tsuga canadensis* (N.H., N.Y., Pa., Va.)
Botryobasidium laeve (Eriksson) Parmasto, on *Pinus resinosa* (Mass.)
Botryobasidium pruinatum (Bres.) Eriksson, on *Picea glauca* (Minn.)
Botryobasidium subcoronatum (Hoehn. & Litsch.) Donk, on *Picea rubens* (N.Y.), on *Pinus strobus* (Mass.), on *Tsuga canadensis* (Wisc.)
Botryobasidium vagum (Berk. & Curtis) D.P. Rogers, on *Pinus strobus* (N.Y.), on *Tsuga canadensis* (N.Y.)
Byssocorticium atrovirens (Fr.:Fr.) Bondartsev & Singer ex Singer, on *Pinus rigida* (N.Y.)
Ceraceomyces tessulatus (Cooke) Juelich, on wood of *Picea* sp. (Maine)
Ceriporia purpurea (Fr.:Fr.) Donk, on wood of *Juniperus virginiana* (Iowa), of *Picea glauca* (Ark.)
Ceriporia spissa (Schw.:Fr.) Rajch., on *Pinus* sp.**
Ceriporia viridens (Berk. & Br.) Donk, on *Picea* sp.
Ceriporia xylostromatoides (Berk.) Ryv. & Johansen, on bark of *Juniperus virginiana* (La.)
Cerocorticium sulfureo-isabellinum (Litsch.) Juelich & Stalpers, on *Abies balsamea* (Ariz., Minn., N.H.)
Cerrena unicolor (Bull.:Fr.) Murr., on *Pinus virginiana* (Va.)
Chaetoderma luna (Romell ex D.P. Rogers & Jacks.) Parmasto, on *Picea glauca* (Ark.)
Clavicorona pyxidata (Pers.:Fr.) Doty, on *Tsuga canadensis* (N.C., Va.)

Climacocystis borealis (Fr.:Fr.) Kotlaba & Pouzar, on *Abies balsamea* **, on *Picea mariana* (Minn., N.Y., Tenn.), on *Picea rubens* (N.Y., Tenn., Vt.), on *Tsuga canadensis* (Mass., N.C., N.Y., Tenn., Va.)

Coltricia focicola (Berk. & Curtis) Murr., on burnt soil under *Pinus rigida* **

Coltriciella dependens (Berk. & Curtis) Murr., on *Pinus rigida* (N.J., **)

Columnocystis abietina (Pers.:Fr.) Pouzar, on *Picea glauca* (Ark.), on *Picea mariana* (Ark., N.Y.), on *Picea rubens* (N.Y.), on *Pinus* sp. (widespread), on fallen logs of *Tsuga canadensis* (Mich.)

Columnocystis ambigua (Peck) Pouzar, on *Picea rubens* (Maine, N.C., N.H., Tenn.), on *Pinus* sp. (northeastern states), on *Tsuga canadensis* (Tenn.)

Confertobasidium olivaceo-album (Bourd. & Galzin) Juelich, on *Pinus resinosa* (Mass.), on *Pinus strobus* (Mass.)

Coniophora arida (Fr.:Fr.) Karst., on *Chamaecyparis thyoides* (N.J.), on *Pinus virginiana* (Md.), on *Pinus* sp. (widespread)

Coniophora arida (Fr.:Fr.) Karst. var *suffocata* (Peck) Ginns, on *Pinus rigida* (Pa.), on *Pinus strobus* (Mass.), on *Tsuga canadensis* (Pa.)

Coniophora fusispora (Cooke & Ellis) Sacc., on *Juniperus virginiana* (Ala., Fla.), on *Pinus rigida* (Mass.)

Coniophora olivacea (Pers.:Fr.) Karst., on *Chamaecyparis thyoides* (N.J.), on *Pinus* sp. (N.J., N.Y.)

Coniophora puteana (Schumach.:Fr.) Karst., on *Abies balsamea* (New England states), on *Picea rubens* (Ark.), on *Tsuga canadensis* (widespread)

Corticium minnsiae (Jacks.) Boidin & Lanquetin, on wood of *Tsuga canadensis* (Maine, N.C., N.Y., Vt.)

Corticium pini (H. Jacks.) Boid. & Lang., on *Pinus strobus* (N.Y.)

Crustoderma dryinum (Berk. & Curtis) Parmasto, on *Picea glauca* (Ark.)

Cryptoporus volvatus (Peck) Shear, on *Picea rubens* **, on *Pinus resinosa* (Mich., Minn., **), on *Pinus rigida* (Mass., N.Y., Vt.), on *Pinus virginiana* (D.C., Md., Va.)

Cystostereum murrayi (Berk. & Curtis) Pouzar, on *Picea rubens* (N.H.)

Cystostereum pini-canadense (Schw.) Parmasto, on *Abies balsamea* (Minn.), on *Picea abies* (N.Y.), on *Picea rubens* (N.H.), on *Tsuga canadensis* (Mich.)

Dacryobolus karstenii (Bres.) Oberwinkler ex Parmasto, on *Picea glauca* (Ark.)

Dacryobolus sudans (Albertini & Schw.:Fr.) Fr., on *Juniperus virginiana* (Fla.)

Dendrophora albobadia (Schw.:Fr.) Chamuris, on dead limbs of *Juniperus virginiana* (La.)

Dendrothele griseo-cana (Bres.) Bourd. & Galzin, on bark of *Juniperus virginiana* (La.)

Dendrothele incrustans (Lemke) Lemke, on wood of *Juniperus virginiana* (La.)

Dendrothele itihummensis Gilb. & Blackwell, on limbs of *Juniperus virginiana* (La., Miss.)

Dendrothele nivosa (Berk. & Curtis ex Hoehn. & Litsch.) Lemke, on bark of *Juniperus virginiana* (Ark., Conn., Fla., Ga., Ind., Kan., La., Mass., Miss., Mo., N.C., N.J., N.Y., Okla., Pa., S.C., Tenn., Texas)

Dendrothele pachysterigmata (Jacks. & Lemke) Lemke, on dead limbs of *Juniperus virginiana* (La.)

Dichomitus squalens (Karst.) D. Reid, on *Picea glauca* (Ark., Minn.), on *Picea mariana* (Minn., N.Y.), on *Picea rubens* (Conn., Maine, N.H., N.Y., Vt.), on *Pinus banksiana* (Mich.), on *Pinus resinosa* (Minn., N.H.), on *Pinus strobus* (Mich., Vt.), on *Tsuga canadensis* (Mass.)

Dichostereum effucatum (Cooke & Ellis) Boidin & Lanquetin, on *Tsuga canadensis* (Conn.)

Diplomitoporus crustulinus (Bres.) Domanski, on *Picea glauca* (Ark.), on *Picea glauca* (Ark.), on *Picea* sp. **

Diplomitoporus linbladii (Berk.) Gilb. & Ryv., on *Picea glauca* (Ark.), on *Pinus rigida* **, on *Tsuga canadensis* **

Diplomitoporus rimosus (Murr.) Gilb. & Ryv., on *Juniperus virginiana* (Okla.)

Echinodontium ballouii (Banker) H. Gross, on wood of *Chamaecyparis thyoides* (N.J.)

Fibulomyces septentrionalis (Eriksson) Juelich, on *Picea glauca* (Ark.)

Fomitopsis cajanderi (Karst.) Kotlaba & Pouzar, on *Chamaecyparis thyoides* (N.C., N.J.), on *Juniperus virginiana* (Ind., S.C., Tenn.), on *Larix laricina* (widespread), on *Picea abies* (N.C.), on *Picea glauca* (widespread), on *Picea rubens* (New England states, N.Y.), on *Pinus virginiana* (Md., Va.) , on *Tsuga canadensis* (N.C., N.Y., Pa., Va.)

Fomitopsis feei (Fr.) Kreisel, on wood of *Juniperus virginiana* (Fla., La.)

Fomitopsis officinalis (Villars:Fr.) Bondartsev & Singer, on *Abies balsamea* (Minn.), on *Larix laricina* (Wisc.), on *Picea glauca* (Minn., S.D.), on *Picea mariana* (Minn.), on *Pinus strobus* (Mich.), on *Tsuga canadensis* (Mich.)

Fomitopsis pinicola (Sw.:Fr.) Karst., on *Abies balsamea* (Minn.), on *Larix laricina* (N.Y., Wisc.), on *Picea glauca* (Ark.), on *Picea mariana* (Minn.), on *Picea rubens* (Conn., Maine, N.H., N.Y., Tenn.), on *Pinus banksiana* (widespread), on *Pinus resinosa* (widespread), on *Pinus rigida* (widespread), on *Pinus strobus* (widespread), on *Pinus virginiana* (eastern states, Tenn.), on *Tsuga canadensis* (widespread, **)

Fomitopsis rosea (Albertini & Schw.:Fr.) Karst., on *Abies balsamea* **, on *Juniperus virginiana* (Ala., Fl;a., Md., Pa., Va.), on *Picea glauca* (Ark.), on *Picea mariana* (Minn.), on *Picea mariana* (Conn., Maine, N.H., N.Y.), on *Pinus banksiana* (widespread), on *Pinus strobus* (widespread), on *Pinus virginiana* (Md., Va.), on *Tsuga canadensis* (eastern states)

Fomitopsis spraguei (Berk. & Curtis) Gilb. & Ryv., on *Tsuga canadensis* (N.C., N.Y.)
Galzinia cymosa D.P. Rogers, on *Pinus resinosa* (Mass.), on *Pinus rigida* (Mass.)
Ganoderma applanatum (Pers.) Pat., on *Abies balsamea* (N.Y.), on *Pinus strobus* (N.Y.), on *Tsuga canadensis* (Mich., N.Y., Pa.)
Ganoderma lucidum (Curtis:Fr.) Karst., on *Picea abies* (Pa.), on *Picea* sp. **, on *Tsuga canadensis* (widespread)
Ganoderma tsugae Murr., on *Picea abies* (Pa.), on *Pinus rigida* (Pa.), on *Tsuga canadensis* (widespread, **)
Gloeocystidiellum ochraceum (Fr.:Fr.) Donk, on *Pinus resinosa* (Mass.)
Gloeocystidiellum porosum (Berk. & Curtis) Donk, on *Picea mariana* (N.Y.), on *Pinus resinosa* (Wisc.)
Gloeophyllum carbonarium (Berk. & Curtis) Ryv., on *Tsuga canadensis* (N.Y., Pa.)
Gloeophyllum odoratum (Fr.) Imaz., on *Juniperus virginiana* (N.Y.), on *Picea glauca* (Ark.), on *Pinus virginiana* (Md., Pa., Va.), on *Tsuga canadensis* (Maine, Wisc.)
Gloeophyllum sepiarium (Fr.) Karst., on *Abies balsamea* (New England states, Minn.), on *Chamaecyparis thyoides* (Va.), on *Larix laricina* (Ark.), on *Picea glauca* (Ark., Maine, Mont., N.M., N.Y., S.D., Vt., Wash., Wyom.), on *Picea mariana* (Minn., N.Y.), on *Picea rubens* (N.C.), on *Pinus strobus* (widespread), on *Tsuga canadensis* (widespread, **)
Gloeophyllum trabeum (Pers.:Fr.) Murr., on *Juniperus virginiana* (Pa.), on *Picea mariana* (N.Y.), on *Picea rubens* (Conn., Maine, N.H., N.Y.), on *Pinus rigida* **, on *Tsuga canadensis* (widespread)
Gloeoporus dichrous (Fr.:Fr.) Bres., on *Juniperus virginiana* (widespread), on *Picea mariana* (N.Y.), on *Pinus resinosa* (Minn.), on *Tsuga canadensis* (N.Y.)
Gloeoporus taxicola (Pers.:Fr.) Gilb. & Ryv., on *Picea* sp. **
Grandinia alutaria (Burt) Juelich, on *Picea glauca* (Minn.)
Grandinia arguta (Fr.:Fr.) Juelich, on *Pinus* sp. (N.Y.)
Grandinia breviseta (Karst) Juelich, on *Abies balsamea* (Minn.), on *Picea mariana* (Minn.)
Grandinia crustosa (Pers.:Fr.) Fr., on *Juniperus virginiana* (Fla.)
Grandinia floccosa (Bourd. & Galzin) Juelich, on *Pinus resinosa* (N.Y.)
Grandinia granulosa (Pers.:Fr.) Fr., on *Picea glauca* (Minn.)
Grandinia nespori (Bres.) Cejp, on dead limbs of *Juniperus virginiana* (Fla.)
Grandinia pallidula (Bres.) Juelich, on *Pinus resinosa* (Minn.), on *Tsuga canadensis* (Wisc.)
Grandinia spathulata (Schrad.:Fr.) Juelich, on *Juniperus virginiana* (Fla.), on *Pinus resinosa* (Minn., N.Y.), on *Tsuga canadensis* (N.Y.)
Grandinia stenospora (Karst.) Juelich, on *Picea glauca* (Ark., Minn.), on *Pinus resinosa* (Minn., N.Y.), on *Pinus strobus* (Mass.)
Grandinia subalutacea (Karst.) Juelich, on *Pinus resinosa* (Minn.), on *Pinus strobus* (N.Y.)
Hapalopilus salmonicolor (Berk. & Curtis) Pouzar, on *Picea* sp. **, on *Pinus strobus* **
Henningsomyces candidus (Pers.:Fr.) Kuntze, on *Juniperus virginiana* (La.), on *Pinus strobus* (N.Y.), on *Tsuga canadensis* (Tenn.)
Hericium americanum Ginns, on wood of *Tsuga canadensis* (N.Y.)
Heterobasidion annosum (Fr.:Fr.) Bref., on *Chamaecyparis thyoides* (Mich., N.Y.), on *Juniperus virginiana* (Del., Ga., Maryland, Mass., N.C., N.Y., S.C., Tenn., Va.), on *Picea glauca* (Minn.), on *Picea rubens* (Maine, Vt.), on *Pinus banksiana* (widespread), on *Pinus resinosa* (northeastern states, Maine, Calif., Mich., Minn., N.H., N.Y., Vt.), on *Pinus rigida* (northeastern states, Mass., N.C.), on *Pinus strobus* (northerstern states, north central states, Iowa, N.C.), on *Pinus sylvestris* (Conn., Mich.), on *Pinus virginiana* (Md., N.C., Ohio, Va.), on *Tsuga canadensis* (Conn., **)
Hexagonia papyracea Berk., on *Thuja occidentalis* **
Hymenochaete agglutinans Ellis, on *Pinus strobus* (Pa.), on *Tsuga canadensis* (Pa.)
Hymenochaete tabacina (Sowerby:Fr.) Lev., on wood of *Abies balsamea* (New England states, N.Y.), on *Picea rubens* (Conn., Maine, N.H., N.Y.)
Hymenochaete tenuis Peck, on *Picea glauca* (Ark.)
Hyphoderma argillaceum (Bres.) Donk, on *Tsuga canadensis* (Wisc.)
Hyphoderma baculorubrense Gilb. & Blackwell, on *Juniperus virginiana* (Fla.)
Hyphoderma obtusiforme Eriksson & Strid in Eriksson & Ryv., on wood of *Juniperus virginiana* (Fla.)
Hyphoderma pilosum (Burt) Gilb. & Budington, on *Abies balsamea* (Minn.)
Hyphoderma praetermissum (Karst.) Eriksson, on *Juniperus virginiana* (La.), on *Pinus resinosa* (Mass.)
Hyphoderma setigerum (Fr.:Fr.) Donk, on *Abies balsamea* (Minn.)
Hyphoderma tsugae (Burt) Eriksson & Strid in Eriksson et al., on *Tsuga canadensis* (N.H.)
Hyphodermopsis polonensis (Bres.) Juelich, on *Abies balsamea* (Minn.)
Hyphodontia stipata (Fr.:Fr.) Gilb., on *Abies balsamea* (Minn.)

Hypochnicium bombycinum (Sommerf.Fr.) Eriksson, on dead limbs of *Juniperus virginiana* (Fla.)
Hypochnicium eichleri (Bres.) Eriksson & Ryv., on dead limbs of *Juniperus virginiana* (La.)
Hypochnicium lundellii (Bourd.) Eriksson, on dead limbs of *Juniperus virginiana* (La.)
Hypochnicium punctulatum (Cooke) Eriksson, on wood of *Juniperus virginiana* (Fla.)
Inonotus circinatus (Fr.) Gilb., on *Abies balsamea* (New England states, Minn.), on *Picea glauca* (Minn.), on *Picea mariana* (Minn.), on *Pinus banksiana* (widespread), on *Pinus resinosa* (Minn.), on *Pinus rigida* (Pa.), on *Pinus strobus* (Minn., N.C., N.Y.), on *Tsuga canadensis* (N.Y., Wisc.)
Inonotus tomentosus (Fr.:Fr.) S. Teng, on *Picea abies* (W.Va.), on *Picea glauca* (Ark.), on *Pinus strobus* (N.C.)
Irpex lacteus (Fr.:Fr.) Fr., on *Tsuga canadensis* (Vt.)
Ischnoderma resinosum (Schrad.:Fr.) Karst., on *Juniperus virginiana* (N.C.), on *Picea rubens* (Conn., Maine, N.H., N.Y.), on *Pinus strobus* (N.Y.), on *Tsuga canadensis* (Maine, N.C., **, Tenn., Vt.)
Jahnoporus hirtus (Quel. ex Cooke) Donk, on roots of *Abies balsamea* (Mich.)
Junghuhnia collabens (Fr.) Ryv., on *Picea glauca* (S.D.), on *Picea mariana* (Minn.), on *Picea rubens* (N.H., N.Y.), on *Tsuga canadensis* (N.Y.)
Junghuhnia luteoalba (Karst.) Ryv., on *Picea rubens* (N.H.), on *Pinus rigida* (Pa.), on *Pinus strobus* (Mass., N.Y.), on *Pinus sylvestris* (N.Y.)
Junghuhnia nitida (Pers.:Fr.) Ryv., on *Picea rubens* (N.Y.), on *Tsuga canadensis* (Pa.)
Junghuhnia subfimbriata (Romell) Ginns, on *Picea rubens* (Maine)
Laetiporus sulphureus (Bull.:Fr.) Murr., on *Picea glauca* (Maine), on *Picea rubens* (Maine), on *Pinus resinosa* (Minn.), on *Pinus strobus* (Wisc.), on *Tsuga canadensis* (N.C.)
Laurilia sulcata (Burt) Pouzar, on *Picea glauca* (Ark.), on *Tsuga canadensis* (N.H., N.Y., Pa., Vt., Wisc.)
Lenzites betulina (L.:Fr.) Fr., on *Tsuga canadensis* (N.Y.)
Leptoporus mollis (Pers.:Fr.) Pilat, on *Tsuga canadensis* **
Leptosporomyces galzinii (Bourd.) Juelich, on living limbs of *Juniperus communis* (Mass.)
Leucogyrophana mollusca (Fr.:Fr.) Pouzar, on wood of *Abies balsamea* (Maine)
Lindtneria leucobryophila (Henn.) Juelich, on *Pinus resinosa* (Minn.)
Meruliopsis albostramineus (Torrend) Juelich & Stalpers, on wood of *Tsuga canadensis* (N.C.)
Meruliopsis corium (Fr.:Fr.) Ginns, on *Picea mariana* (Minn.)
Meruliopsis taxicola (Pers.) Bondartsev in Parmasto, on *Chamaecyparis thyoides* (N.J.), on *Picea rubens* (N.H.)
Meruliporia incrassata (Berk. & Curtis) Murr., on *Tsuga canadensis* (widespread)
Oligoporus balsameus (Peck) Gilb. & Ryv., on *Picea* sp. **
Oligoporus floriformis (Quel.) Gilb. & Ryv., on *Thuja occidentalis* **, on *Pinus strobus* **
Oligoporus leucomallellus (Murr.) Gilb. & Ryv., on *Picea* sp. **, on *Pinus strobus* **
Oligoporus fragilis (Fr.) Gilb. & Ryv., on *Pinus sylvestris*?
Oligoporus guttulatus (Peck) Gilb. & Ryv., on conifer **
Oligoporus mappus (Overh. & Lowe) Gilb. & Ryv., on conifer bridge rail **
Oligoporus minusculoides (Pilat) Gilb. & Ryv., on *Tsuga canadensis* **
Oligoporus sericeomollis (Rom.) Pouzar, on *Pinus rigida* **, on *Pinus strobus* **
Oligoporus stipticus (Pers.:Fr.) Gilb. & Ryv., on *Tsuga canadensis* **
Oligoporus subpendulus (Atk.) Gilb. & Ryv., on *Tsuga canadensis* (N.Y.)
Pachykytospora papyracea (Schw.) Ryv., on dead wood of *Chamaecyparis thyoides* (N.J., N.Y., Pa.)
Parmastomyces transmutans (Overh.) Ryv. & Gilb., on *Pinus strobus* **
Paullicorticium pearsonii (Bourd.) Eriksson, on *Tsuga canadensis* (Wisc.)
Peniophora junipericola Eriksson, on dead limbs of *Juniperus virginiana* (La., Miss.)
Peniophora piceae (Pers.) Eriksson, on *Abies balsamea* (Minn.)
Peniophora pini (Schlect.:Fr.) Boidin subsp. *duplex* (Burt) Weresub & Gibson, on *Pinus rigida* (Conn., Mass., N.Y., Pa.), on *Pinus strobus* (Mass., Pa.), on *Pinus sylvestris* (Mass., Pa.), on *Pinus virginiana* (Md., Pa.)
Peniophora pseudopini Weresub & Gibson, on *Pinus resinosa* (N.Y.), on *Pinus strobus* (Mass., Pa.)
Peniophora pusilla H. Jacks., on bark of *Tsuga canadensis* (N.H.)
Perenniporia medulla-panis (Jacq.:Fr.) Donk, on *Picea* sp. **
Perenniporia subacida (Peck) Donk, on *Abies balsamea* (widespread), on *Juniperus virginiana* (Idaho, N.Y.), on *Picea glauca* (Maine), on *Picea rubens* (Conn., Maine, N.H., N.Y., Vt.), on *Pinus resinosa* (Great Lake states), on *Pinus strobus* (northeastern states), on *Pinus virginiana* (Md., Va.), on *Tsuga canadensis* (eastern states, **)
Perenniporia tenuis (Schw.) Ryv., on wood of *Picea* sp. (N.Y., Pa.), on *Tsuga canadensis* (N.C.)
Phaeolus schweinitzii (Fr.:Fr.) Pat., on *Abies balsamea* (New England states, N.Y.), on *Larix laricina* (widespread, **), on

Picea abies **, on *Picea glauca* (widespread), on *Picea mariana* (New England states, Minn.), on *Picea rubens* (Maine, Mass., N.Y., Vt.), on *Pinus banksiana* (widespread), on *Pinus resinosa* (widespread), on *Pinus strobus* (widespread, **), on *Pinus sylvestris* (N.Y.), on *Pinus virginiana* (Md., Va.)

Phanerchaete carnosa (Burt) Parmasto, on *Abies balsamea* (Mich., Minn.), on *Juniperus communis* (N.Y.), on *Juniperus virginiana* (Mass.), on *Picea mariana* (Minn.), on *Picea rubens* (Maine, Mass., N.H., Vt.), on *Pinus rigida* (N.H.), on *Pinus strobus* (Mass., Minn.)

Phanerchaete flavido-alba (Cooke) Rattan, on *Juniperus virginiana* (Ga., La.)

Phanerchaete gigantea (Fr.:Fr.) Rattan et al. in Rattan, on *Abies balsamea* (Minn.), on *Picea glauca* (Ark.), on *Pinus banksiana* (Mich.), on *Pinus resinosa* (Wisc.), on *Pinus strobus* (widespread), on *Tsuga canadensis* (Mich.)

Phanerchaete sanguinea (Fr.:Fr.) Pouzar, on *Pinus banksiana* (Mich.), on *Pinus resinosa* (Mass., Minn.), on *Pinus rigida* (N.Y.), on *Tsuga canadensis* (Wisc.)

Phanerchaete velutina (DC.:Fr.) Karst., on *Picea* sp. (N.Y.), on *Pinus resinosa* (Wisc.), on *Pinus strobus* (Mich.)

Phanerchaete viticola (Schw.) Parmasto, on *Abies balsamea* (N.H.), on *Picea* sp. (N.Y.)

Phellinus ferruginosa (Schrad.:Fr.) Karst., on *Abies balsamea* **, on *Thuja occidentalis* **, on *Tsuga canadensis* **

Phellinus gilvus (Schw.:Fr.) Pat., on *Juniperus virginiana* (widespread), on *Tsuga canadensis* (Pa.)

Phellinus pini (Thore:Fr.) Ames, on *Abies balsamea* (Minn., **), on *Juniperus virginiana* (Mass.), on *Larix laricina* (widespread, **), on *Picea glauca* (widespread), on *Picea mariana* (widespread, **), on *Picea rubens* (Conn., Maine, N.C., N.H., N.Y., W.Va.), on *Pinus banksiana* (widespread), on *Pinus resinosa* (widespread), on *Pinus rigida* (widespread, **), on *Pinus strobus* (widespread), on *Pinus sylvestris* (widespread), on *Pinus virginiana* (eastern states, Tenn.), on *Tsuga canadensis* (eastern states)

Phellinus punctatus (Fr.) Pilat, on *Abies balsamea* **, on *Picea* sp. **, on *Tsuga canadensis* (eastern states, Ga., **, Ohio)

Phellinus robustus (Karst.) Bourd. & Galzin, on *Abies balsamea* (Minn.), on *Tsuga canadensis* (widespread)

Phellinus texanus (Murr.) Ames, on *Juniperus virginiana* (Texas)

Phellinus viticola (Schw.:Fr.) Donk, on *Abies balsamea* (Minn.), on *Larix laricina* (Ark.), on *Picea abies* (northwestern states, Ark.), on *Picea mariana* (Ark.), on *Tsuga canadensis* (N.Y.)

Phlebia livida (Pers.:Fr.) Bres., on *Pinus strobus* (N.C.)

Phlebia tremellosus (Schrad.:Fr.) Nakasone & Burdsall, on *Tsuga canadensis* (N.Y.)

Phlebiella tulasnelloidea (Hoehn. & Litsch.) Oberwinkler, on *Pinus strobus* (N.Y.)

Phlebiella vaga (Fr.:Fr.) Karst., on *Pinus strobus* (N.Y.), on *Tsuga canadensis* (Mass.)

Piloderma bicolor (Peck) Juelich, on *Picea glauca* (Ark.), on *Tsuga canadensis* (Wisc.)

Piloderma byssinum (Karst.) Juelich, on *Picea glauca* (Minn.)

Polyporus badius (Pers.) Schw., on *Tsuga canadensis* (Mich.)

Polyporus virgatus Berk. & Curtis, on *Pinus rigida* **, on *Pinus strobus* **

"Poria pini" (Peck) Sacc., on *Pinus rigida* **

Postia balsamea (Peck) Juelich, on *Abies balsamea* (widespread)

Postia caesia (Schrad.:Fr.) Karst., on *Abies balsamea* (Minn.), on *Juniperus virginiana* (widespread), on *Picea glauca* (Calif.), on *Picea mariana* (Ark.), on *Picea rubens* (Conn., Maine, N.H., N.Y.), on *Tsuga canadensis* (Maine, N.C.)

Postia fragilis (Fr.:Fr.) Juelich, on *Picea mariana* (Minn.) , on *Pinus strobus* (N.C.), on *Tsuga canadensis* (N.C.)

Postia guttulata (Peck) Juelich, on *Abies balsamea* (widespread), on *Picea glauca* (widespread), on *Picea mariana* (Minn.), on *Picea rubens* (N.Y., Pa., Wash.), on *Tsuga canadensis* (N.Y.)

Postia stiptica (Pers.:Fr.) Juelich, on *Tsuga canadensis* (N.Y.)

Postia undosa (Peck) Juelich, on *Abies balsamea* (N.H.), on *Picea rubens* (Maine, N.H., N.Y.), on *Pinus rigida* (Conn.), on *Pinus strobus* (Conn., N.Y.), on *Tsuga canadensis* (N.Y.)

Pseudomerulius aureus (Fr.:Fr.) Juelich, on *Tsuga canadensis* (N.Y.)

Pseudomerulius curtisii (Berk.) Redhead & Ginns, on *Tsuga canadensis* (N.C.)

Pseudotomentella griseopergamacea Larsen, on *Pinus resinosa* (N.Y.), on *Pinus strobus* (N.Y.), on *Tsuga canadensis* (N.Y.)

Pseudotomentella nigra (Hoehn. & Litsch.) Svrcek, on *Pinus strobus* (N.Y.)

Pseudotomentella tristis (Karst.) Larsen, on *Picea rubens* (N.Y.)

Pycnoporellus alboluteus (Ellis & Everh.) Kotlaba & Pouzar, on *Picea glauca* (Ark.), on *Picea mariana* (Mich.), on *Picea rubens* (N.Y.)

Pycnoporellus fulgens (Fr.) Donk, on *Abies balsamea* **, on *Picea glauca* (Ark.), on *Picea mariana* (Minn.), on *Picea rubens* (N.C., N.Y.), on *Tsuga canadensis* (N.Y., Tenn.)

Pycnoporus cinnabarinus (Jacq.:Fr.) Karst., on *Picea rubens* (N.Y.), on *Tsuga canadensis* (Pa., Vt.)

Pyrofomes demidoffii (Lev.) Kotlaba & Pouzar, on *Juniperus communis* (Mont.), on *Juniperus virginiana* (Kentucky, Md., Okla., Tenn.)

Ramaricium polyporoideum (Berk. & Curtis) Ginns, on *Pinus sylvestris* (N.Y.)
Resinicium bicolor (Albertini & Schw.:Fr.) Parmasto, on *Picea* sp. (N.Y.), on *Pinus resinosa* (Mass.), on *Pinus strobus* (N.Y.)
Resinicium furfuraceum (Bres.) Parmasto, on *Pinus resinosa* (Mass.), on *Pinus strobus* (Mass., Minn.), on *Tsuga canadensis* (N.H., Wisc.)
Schizophyllum commune Fr.:Fr., on *Picea rubens* (Conn., Maine, N.H., N.Y.), on *Tsuga canadensis* (N.C.)
Schizopora paradoxa (Schrad.:Fr.) Donk, on dead limbs of *Juniperus virginiana* (La.)
Scytinostroma arachnoideum (Peck) Gilb., on *Picea rubens* (N.H.)
Scytinostroma galactinum (Fr.) Donk, on *Abies balsamea* (Maine, Minn., N.Y.), on *Larix laricina* (N.Y.), on *Picea glauca* (Minn.), on *Picea rubens* (Conn., Maine, N.H., N.Y.), on *Pinus resinosa* (Minn.), on *Pinus strobus* (Conn.), on *Tsuga canadensis* (Md.)
Scytinostroma ochroleucum (Bres. & Torrend) Donk, on *Tsuga canadensis* (N.H.)
Scytinostroma portentosum (Berk. & Curtis in Berk.) Donk, on dead limbs of *Juniperus virginiana* (La.)
Scytinostromella nannfeldtii (Eriksson) Freeman & Peterson, on *Picea glauca* (Ark.)
Sistotrema brinkmannii (Bres.) Eriksson, on *Pinus strobus* (Ga.), on *Tsuga canadensis* (Conn.)
Sistotrema raduloides (Karst.) Donk, on *Picea glauca* (Ark.)
Skeletocutis amorpha (Fr.:Fr.) Kotlaba & Pouzar, on *Picea* sp. (widespread), on *Pinus rigida* (Pa.), on *Tsuga canadensis* (Pa.)
Skeletocutis nivea (Jungh.) Keller, on *Chamaecyparis thyoides* **
Skeletocutis stellae (Pilat) Keller, on *Picea rubens* **
Sphaerobasidium minutum (Eriksson) Oberwinkler, on *Tsuga canadensis* (Wisc.)
Spongipellis spumeus (Sowerby:Fr.) Pat., on *Tsuga canadensis* (Maine)
Steccherinum fimbriatum (Pers.:Fr.) Eriksson, on *Pinus resinosa* (N.Y.)
Steccherinum ochraceum (Pers.:Fr.) S.F. Gray, on wood of *Juniperus virginiana* (Fla.)
Steccherinum subcrinale (Peck) Ryv., on *Pinus strobus* (Mass.), on *Tsuga canadensis* (N.Y.)
Stereum hirsutum (Willd.:Fr.) S.F. Gray, on *Juniperus virginiana* (Conn., N.C.)
Stereum sanguinolentum (Albertini & Schw.:Fr.) Fr., on *Abies balsamea* (Maine, Mich., N.H., N.Y., Vt.), on *Picea abies* (Idaho, N.Y., Vt.), on *Picea glauca* (Ark.), on *Picea rubens* (Conn., Maine, N.H., N.Y., Vt.), on *Pinus banksiana* (Conn.), on *Pinus resinosa* (Conn., Mass., N.H., N.Y.), on *Pinus rigida* (Mass.), on *Pinus strobus* (widespread), on *Tsuga canadensis* (widespread)
Subulicystidium longisporum (Pat.) Parmasto, on *Abies balsamea* (Minn.)
Suillosporium cystidiatum (D.P. Rogers) Pouzar, on wood of *Tsuga canadensis* (Conn.)
Thelephora albidobrunnea Schw., on *Juniperus virginiana* (N.C.)
Thelephora cuticularis Berk., on bark of *Juniperus virginiana* (Fla.)
Thelephora terrestris Ehrh.:Fr., "smothering of seedlings" of *Picea mariana* (Minn.), on *Pinus banksiana* (Mich.), on *Pinus strobus* (Maine, N.H., Ohio)
Tomentella asperula (Karst.) Hoehn. & Litsch., on wood of *Juniperus virginiana* (Fla., La.)
Tomentella atrorubra (Peck) Bourd. & Galzin, on *Picea* sp. (N.Y.), on *Pinus strobus* (N.Y.), on *Tsuga canadensis* (Mass., N.Y.)
Tomentella avellanea (Burt) Bourd. & Galzin, on *Pinus* sp. (N.Y.)
Tomentella botryoides (Schw.) Bourd. & Galzin, on *Pinus* sp. (N.Y.), on *Tsuga canadensis* (N.C.)
Tomentella bresadolae (Brinkmann) Bourd. & Galzin, at base of living *Juniperus virginiana* on exposed heartwood (Ohio), on *Picea* sp. (N.Y.)
Tomentella bryophila (Pers.) Larsen, on *Tsuga canadensis* (Mich., N.Y., Vt.)
Tomentella coerulea (Bres.) Hoehn. & Litsch., on *Tsuga canadensis* (Mich.)
Tomentella crinalis (Fr.) Larsen, on *Tsuga canadensis* (N.Y.)
Tomentella griseo-umbrina Litsch. in Lundell, on *Tsuga canadensis* (N.Y.)
Tomentella lateritia Pat., on *Tsuga canadensis* (Mich., N.Y.)
Tomentella neobourdotii Larsen, on *Tsuga canadensis* (Mich., Tenn.)
Tomentella ochracea (Sacc.) Larsen, on *Picea* sp. (N.Y., N.J.)
Tomentella olivascens (Berk. & Curtis) Bourd. & Galzin, on *Picea* sp. (N.Y.), on *Pinus strobus* (Mass.), on *Pinus* sp. (N.Y.), on *Tsuga canadensis* (Mass., N.Y.)
Tomentella punicea (Albertini & Schw.:Fr.) Schroet. in Cohn, on *Pinus* sp. (N.Y.), on *Tsuga canadensis* (Mich.)
Tomentella ramosissima (Berk. & Curtis) Wakef., on *Pinus* sp. (widespread)
Tomentella rubiginosa (Bres.) Maire, on *Picea rubens* (N.H.), on *Pinus* sp. (N.Y.)
Tomentella ruttneri Litsch., on *Picea* sp. (Mich., N.Y.), on *Pinus* sp. (Ark., N.Y.), on *Tsuga canadensis* (N.Y.)
Tomentella sublilacina (Ellis & Holway) Wakef., on *Picea* sp. (Mich., N.Y.), on *Pinus* sp. (Mass., Md., N.Mex., N.Y., Tenn.), on *Tsuga canadensis* (Mass., N.Y.)

Tomentella terrestris (Berk. & Broome) Larsen, on *Pinus* sp. (Ariz., Mont., N.Mex., N.Y.), on *Tsuga canadensis* (N.Y.)
Trametes hirsuta (Wulfen:Fr.) Quel., on *Juniperus virginiana* (N.C.), on *Tsuga canadensis* (N.Y.)
Trametes versicolor (L.:Fr.) Pilat, on *Abies balsamea* (N.Y.), on *Juniperus virginiana* (widespread, **), on *Picea rubens* (Conn., Maine, N.H., N.Y.), on *Pinus* sp. (widespread), on *Tsuga canadensis* (widespread)
Trametes villosa (Fr.:Fr.) Kreisel, on *Chamaecyparis thyoides* (N.C., Va.), on *Juniperus virginiana* (Mo., Tex.)
Trechispora cohaerens (Schw.) Juelich & Stalpers, on *Abies balsamea* (Minn.)
Trechispora farinacea (Pers.:Fr.) Liberta, on *Juniperus virginiana* (Fla.), on *Pinus resinosa* (N.Y.), on *Pinus sylvestris* (N.Y.), on *Tsuga canadensis* (Wisc.)
Trechispora lunata (Bourd. & Galzin) Juelich, on *Pinus resinosa* (Mass.)
Trechispora mollusca (Pers.:Fr.) Liberta, on *Abies balsamea* **, on *Picea* sp. **, on *Thuja occidentalis* **
Trichaptum abietinum (Dickson:Fr.) Ryv., on *Chamaecyparis thyoides* (Maine, **), on *Juniperus virginiana* (N.C.), on *Larix laricina* (Ark., **), on *Picea glauca* (Ark., Maine), on *Picea mariana* **, on *Picea rubens* (Conn., Maine, N.H., N.Y., Pa.), on *Pinus resinosa* (Mich.), on *Pinus rigida* **, on *Tsuga canadensis* (widespread)
Trichaptum biforme (Fr.) Ryv., on *Picea glauca* (Ark.), on *Tsuga canadensis* (Ga., N.Y., Pa.)
Trichaptum fusco-violaceum (Fr.) Ryv., on *Abies balsamea* **, on *Picea* sp. **
Trichaptum laricinum (Karst.) Ryv., on *Picea rubens* (N.Y.)
Trichaptum sector (Ehrenb.:Fr.) Kreisel, on *Chamaecyparis thyoides* (N.C.)
Tubulicium clematidis (Bourd. & Galzin) Oberwinkler, on wood of *Juniperus virginiana* (Fla.)
Tubulicrinis accedens (Bourd. & Galzin) Donk, on *Pinus strobus* (Mass.), on *Tsuga canadensis* (R.I.)
Tubulicrinis angustus (D.P. Rogers & Weresub) Donk, on *Pinus strobus* (R.I.), on *Tsuga canadensis* (Wisc.)
Tubulicrinis calothrix (Pat.) Donk, on *Pinus strobus* (Mass.), on *Tsuga canadensis* (Wisc.)
Tubulicrinis glebulosus (Bres.) Donk, on wood of *Tsuga canadensis* (Wisc.)
Tubulicrinis medius (Bourd. & Galzin) Oberwinkler, on dead limbs of *Juniperus virginiana* (La.)
Tubulicrinis propinquus (Bourd. & Galzin) Donk, on *Picea glauca* (Mass.)
Tubulicrinis sceptriferus (H. Jacks. & Weresub) Donk, on wood of *Tsuga canadensis* (Wisc.)
Tubulicrinis subulatus (Bourd. & Galzin) Donk, on *Pinus resinosa* (Mass.), on *Pinus strobus* (Mass.)
Vararia boreale Pouzar, on *Pinus resinosa* (Minn.)
Vararia gomezii Boidin & Lanquetin, on dead limbs of *Juniperus virginiana* (La.)
Vararia investiens (Schw.) Karst., on *Abies balsamea* (Maine), on *Picea rubens* (N.H.), on *Pinus strobus* (N.Y.)
Wolfiporia cocos (F.A. Wolf) Ryv. & Gilb., on *Abies balsamea* (Minn., Pa.), on *Juniperus virginiana* (N.C.), on *Tsuga canadensis* (Wisc.)
Wrightoporia lenta (Overh. & Lowe) Pouzar, on *Tsuga canadensis* (N.Y.)
Wrightoporia subrutilans (Murr.) Ryv., on *Abies balsamea* (Maine), on *Tsuga canadensis* (Vt.)
Xenasma pulverulentum (Litsch.) Donk, on *Tsuga canadensis* (Wisc.)
Xenosperma murrillii Gilb. & Blackwell, on limbs of *Juniperus virginiana* (Fla.)
Xylobolus frustulans (Pers.:Fr.) Karst., on stumps of *Pinus strobus* (N.C., S.C.)

AGARICALES

Anthracophyllum lateritium (Berk. & Curtis) Singer, on dead limbs of *Juniperus virginiana* (La.)
Armillaria mellea (Vahl:Fr.) Kumm., on *Abies balsamea* (New England states, Minn.), on *Chamaecyparis thyoides* (Va.), on *Picea glauca* (Vt.), on *Picea rubens* (Conn., Maine, Mass.), on *Pinus banksiana* (Mich., Minn.), on *Pinus rigida* (Pa.), on *Pinus strobus* (widespread), on *Tsuga canadensis* (northeastern states, Ga., Mich., N.C.)
Baeospora myosura (Fr.:Fr.) Singer, on cones of *Pinus strobus* (Minn.)
Clitocybe martiorum J. Favre, on dead needles of *Pinus strobus* (Mich.), of *Pinus sylvestris* (Mich.)
Clitocybula abundans (Peck) Singer, on wood of *Tsuga canadensis* (Vt.)
Collybia acervata (Fr.:Fr.) Kumm., on debris, logs, and stumps of *Picea rubens* (N.C., Tenn., Va., W.Va.)
Crepidotus fusisporus Hesler & A.H. Smith var. *abietinus* Hesler & A.H. Smith, on dead twigs of *Abies balsamea* (Mich.)
Cyphellopsis anomala (Pers.:Fr.) Donk, on *Abies balsamea* (N.H.)
Cyptotrama asprata (Berk.) Redhead & Ginns, on *Picea rubens* (N.C., Tenn.)
Galerina autumnalis (Peck) A.H. Smith & Singer, on dead limbs of *Pinus virginiana* (Va.)
Galerina tsugae A.H. Smith & Singer, on logs of *Tsuga canadensis* (Mich.)
Gymnopilus naucorioides Hesler, on stumps of *Tsuga canadensis* (Tenn.)
Gymnopilus pulchrifolius (Peck) Murr., on wood of *Tsuga canadensis* (N.Y.)
Hemimycena albida (Murr.) Singer, on *Juniperus virginiana* (Fla.)

Hohenbuehelia approximans (Peck) Singer, on *Juniperus virginiana* (Fla.)
Hohenbuehelia elegans (Coker) Singer, on bark of living trees? (N.C.)
Hydropus marginellus (Pers.:Fr.) Singer, on *Picea rubens* (N.C., Tenn., Va., W.Va.)
Hypholoma capnoides (Fr.:Fr.) Kumm., on wood of *Tsuga canadensis* (N.C.)
Hypholoma fasciculare (Huds.:Fr.) Kumm., on *Juniperus virginiana* (Fla.), on *Pinus strobus* (N.C.)
Hypsizygus tesselatus (Bull.:Fr.) Singer, on wood of *Tsuga canadensis* (N.C.)
Marasmiellus filopes (Peck) Redhead, on *Abies balsamea* (N.Y.)
Marasmiellus juniperinus Murr., on living limbs of *Juniperus virginiana* (La.)
Mycena austinii (Peck) Kuehner, on wood of *Picea* sp. (N.Y.)
Mycena borealis A.H. Smith, on wood of *Picea rubens* (Va., W.Va.)
Mycena clavicularis (Fr.:Fr.) Gill., on dead needles of *Pinus virginiana* (Va.)
Mycena longiseta Hoehn., on dead needles of *Picea rubens* (Va.)
Mycena plumbea (Fr.) Sacc., on dead needles of *Picea* sp. (Colo., Mich., N.Y.)
Mycena subincarnata (Peck) Sacc., on dead needles of *Pinus strobus* (N.Y.)
Mycena subplicosa Karst., on dead needles of *Picea* sp. (Calif., Mich., N.Y., Oreg., Wash.)
Mycena tenax A.H. Smith, on dead needles of *Abies balsamea* (N.Y.), on dead needles of *Picea rubens* (N.Y.)
Neolentinus adhaerens (Albertini & Schw.:Fr.) Redhead & Ginns, on *Tsuga canadensis* (Maine, N.H.)
Neolentinus lepideus (Fr.:Fr.) Redhead & Ginns, on *Picea rubens* (Conn., Maine, N.H., N.Y.), on *Pinus banksiana* (Minn.), on *Pinus strobus* (widespread)
Omphalina epichysium (Pers.:Fr.) Quel., on stumps of *Tsuga canadensis* (Tenn.)
Panellus pusillus (Peck) Burdsall & O.K. Miller, on *Pinus strobus* (S.C.)
Panellus stipticus (Bull.:Fr.) Karst., on *Picea rubens* (Conn., Maine, N.H., N.Y.)
Paxillus atrotomentosus (Batsch:Fr.) Fr., on decaying logs of *Tsuga canadensis* (Ga., N.C., S.C.)
Pholiota alnicola (Fr.:Fr.) Singer, on *Tsuga canadensis* (N.C.)
Pholiota flammans (Fr.:Fr.) Kumm., on *Tsuga canadensis* (N.C.)
Pholiota squarrosoides (Peck) Sacc., on *Tsuga canadensis* (N.C.)
Pluteus fuliginosus Murr., on stumps of *Pinus strobus* (N.Y.)
Psathyrella atomatoides (Peck) A.H. Smith, on *Tsuga canadensis* (N.C.)
Resupinatus applicatus (Batsch:Fr.) S.F. Gray, on *Juniperus virginiana* (N.C.)
Stigmatolemma taxi (Lev.) Donk, on bark of *Juniperus virginiana* (Fla., Ga., La., S.C.)
Strobilurus occidentalis V. Wells & P. Kempton, on cones of *Picea glauca* (Ark.)
Tricholomopsis decora (Fr.:Fr.) Singer, on *Tsuga canadensis* (N.C.)
Tricholomopsis rutilans (Schaeff.:Fr.) Singer, on *Picea* sp. (N.H.)
Tricholomopsis sulfureoides (Peck) Singer, on wood of *Tsuga canadensis* (N.Y.)
Xeromphalina campanella (Batsch:Fr.) Kuehner & Maire, on rotten logs and stumps of *Picea rubens* (N.C., Tenn., Va., W.Va.)

NIDULARIALES

Crucibulum laeve (Bull.) Kambly in Kambly & Lee, on *Juniperus virginiana* (N.C.)

LYCOPERDALES

Lycoperdon pyriforme Schaeff.:Pers., on Tsuga canadensis (N.C.)

MONILIALES

Aureobasidium pullans (de Bary) Arnaud, on *Pinus resinosa* (northeastern states, Wisc.)
Berkleasmium concinnum (Berk.) Moore, on *Tsuga canadensis* (N.C.)
Botrytis cinerea Pers.:Fr., seedling blight, on *Picea abies* (N.J.), on *Picea rubens* (N.C.)
Cephalosporium sp., canker on *Abies balsamea* (Minn., Wisc.)
Cercospora sequoiae Ellis & Everh., on *Juniperus virginiana* (Ga., S.C.)
Cercospora sequoiae Ellis & Everh. var *juniperi* Ellis & Everh., on *Juniperus communis* (Conn., Wisc.), on *Juniperus virginiana* (Ark., Fla., Ga., Mo., N.C., Neb., Okla., S.C., Va., Wisc.)
Chalara thielavioides (Peyronel) Nag Rag & Kendrick, black mold on *Juniperus virginiana* (N.J.)
Confistulina hepatica (Sacc.) Stalpers in Stalpers & Vlug, on *Pinus virginiana* (Md.)

Conoplea abietina (Peck) Hughes, on *Picea* sp. (N.Y.)
Conoplea fusca Pers., on *Juniperus virginiana* (N.C.)
Conoplea geniculata (Corda) Hughes, on *Abies balsamea* (N.Y.)
Conoplea juniperi Hughes, on dead needles and limbs of *Juniperus virginiana* (Conn., Del., Ind., Marlyland, Mass., Mich., N.C., N.J., N.Y., Ohio, Pa.)
Corynespora olivacea (Wallr.) Ellis, on *Tsuga canadensis* (W.Va.)
Curvularia intermedia Boedijn, seedling tip blight on *Juniperus virginiana* (Ariz.)
Cylindrocladium scoparium Morg., damping off, on *Picea abies* (N.J.), on *Picea glauca* (Minn.), on *Picea mariana* (Minn.), on *Pinus resinosa* (Minn.), on *Pinus rigida* (N.J., Pa.), on *Pinus strobus* (N.C., N.J., W.Va.), on *Tsuga canadensis* (N.J.)
Eustilbum aureum (Pers.:Fr.) Seifert & Carp., on resin of *Abies balsamea* (N.Y.)
Fusarium avenaceum (Fr.:Fr.) Sacc., seedling blight, on *Pinus resinosa* (Pa.)
Fusarium lateritium Nees:Fr., on *Pinus strobus* (Va.)
Fusarium lateritium Nees:Fr. f.sp. *pini* Hepting, on *Pinus rigida* (N.C.), on *Pinus virginiana* (Fla., Ga., N.C., S.C., Va.)
Fusarium oxysporum Schlect.:Fr., on *Pinus resinosa* (N.Y., Pa.)
Fusarium subglutinans (Wollenweb & Reinking) P.E. Nelson, Toussoun & Marasas, on *Pinus sylvestris* (N.C.)
Haplotrichum ramosissimum (Berk. & Curtis) Holubova-Jechova, on roots of *Tsuga canadensis* (Vt.)
Hyalotrochophora lignitalis (Thaxt.) Finley & Morris, on *Pinus strobus* (Mass.)
Illosporium conicola Ellis & Everh. in Shear, on cones of *Pinus virginiana* (D.C.)
Leptographium procerum (Kendrick) Wingfield, on *Pinus strobus* (Minn., N.Y., Pa., Va.), on *Pinus sylvestris* (Mass., Va.)
Leptographium terebrantis Barras & Perry, blue stain associated with the beetle, *Dendroctonus terebrans*, on *Pinus sylvestris* (Mass.)
Pullularia sp., isolated from basal cankers on *Pinus strobus* (N.Y.)
Sporidesmium hysterioideum Cooke & Ellis, on *Juniperus virginiana* (Del.)
Stigmina defectens (Karst.) Ellis, on *Juniperus virginiana* (S.D.)
Stigmina glomerulosa (Sacc.) Hughes, needle blight, twig blight on *Juniperus communis* (Iowa, Utah), on *Juniperus virginiana* (N.C., S.C., Va.)
Stigmina juniperina (Georgescu & Badea) Ellis, needle cast on *Juniperus communis* (Mich., Wisc.)
Tuberculina maxima Rostr., on *Pinus strobus* (Mich.)

SPHAEROPSIDALES

Aplosporella juniperi (Peck) Petr., on *Juniperus virginiana* (Kan., Mich., N.Y.)
Aplosporella pini Peck, on *Pinus strobus* (N.Y.)
Ascochyta conicola Dearn. & House, nom. nud., on cone scales of *Tsuga canadensis* (N.Y.)
Bothrodiscus bernice (Berk. & Curtis) Groves, on branches of *Abies balsamea* (Mich., Minn.)
Botryodiplodia juniperina (Peck) Petr. & Syd., on dead limbs of *Juniperus virginiana* (N.Y.)
Camarosporium pini (Westend.) Sacc., on twigs of *Pinus strobus* (Pa.)
Cytospora chrysosperma (Pers.:Fr.) Fr., canker on *Picea abies* (New England states, Ill.)
Cytospora kunzei Sacc., canker on *Abies balsamea* (Maine, Vt.), on *Picea abies* (Conn., Mass.), on *Picea glauca* (Conn., Mass., N.J.), on *Picea rubens* (Maine, N.H., N.Y.), on *Pinus strobus* (Conn., Maine, N.C.), on *Tsuga canadensis* (Conn., N.C., N.H.)
Cytospora leucostoma Sacc., canker on *Picea abies* (New England states, Ill.)
Cytospora pinastri Fr.:Fr., twig and branch canker and on needles of *Abies balsamea* (Maine, Minn., Wisc.), on *Pinus sylvestris* (Maine, N.J., Pa.)
Diplodia megalospora Berk. & Curtis, blue-gray stain on *Pinus strobus* (N.Y.), on *Pinus virginiana* (Va.)
Diplodia thyoidea Cooke & Ellis, on bark of *Chamaecyparis thyoides* (N.J.)
Diplodia virginiana Cooke & Rav., on twigs of *Juniperus virginiana* (S.C.)
Dothistroma septospora (Doroguine) Morelet, on *Pinus resinosa* (Ohio, Okla.), on *Pinus sylvestris* (Va.)
Foveostroma abietinum (Peck) DiCosmo, on *Abies balsamea* (Maine), on *Tsuga canadensis* (N.C.)
Harknessia thujina Ellis & Everh., on foliage of *Chamaecyparis thyoides* (N.Y.), on *Juniperus virginiana* (Texas)
Hendersonia thyoides Cooke & Ellis, on foliage of *Chamaecyparis thyoides* (N.J.)
Hendersonula pinicola Dearn., on *Pinus strobus* (N.C., Tenn.)
Leptostroma rostrupii Minter, on *Pinus sylvestris* (Wash.)
Leptothyrium stenosporum Dearn., on *Pinus strobus* (Ga.)
Macrophomina phaseolina (Tassi) Goidanich, charcoal rot of *Juniperus virginiana* (Okla.), damping off of *Picea abies* (N.C.)

Phacidiopycnis pseudotsugae M. Wilson) G. Hahn, on *Abies balsamea* (New England states), on *Larix laricina* (New England states), on *Pinus strobus* (northeastern states), on *Tsuga canadensis* (Pa.)
Phoma acutum Cooke & Ellis, on twigs and cones of *Pinus* sp. (N.J., N.Y.)
Phoma bacteriophila Peck, on *Pinus strobus* (N.Y.)
Phoma harknessii Sacc., on twigs and cones of *Pinus strobus* (northeastern states)
Phomopsis conorum (Sacc.) Died., on *Pinus strobus* (Iowa), on *Pinus sylvestris* (Iowa)
Phomopsis juniperovora Hahn, on *Juniperus communis* (eastern states, Kan., Neb.), *Juniperus virginiana* (widespread)
Phomopsis occulta (Sacc.) Traverso, needle necrosis, on *Juniperus virginiana* (Maryland, Mass.), on *Picea* sp. (New England states, on *Tsuga canadensis* (Mass., N.J., N.Y.)
Phomopsis strobi Syd. in Syd. & Petr., on limbs, associated with rust galls, on *Pinus strobus* (Maine)
Pseudocenangium succineum (Spree) Dyko & Sutton, on needles of on *Pinus rigida* (N.J.)
Rhabdospora mirabillissima (Peck) Dearn. & House, stem canker of seedlings of *Pinus strobus* (N.Y.)
Rhabdospora pinea (Berk. & Curtis) Sacc., on limbs of *Pinus sylvestris* (Wisc.)
Rhizosphaera kalkhoffii Bubak, Swiss needle cast, on *Picea abies* (Pa.), on *Picea glauca* (Pa.), on *Picea mariana* (Pa.)
Sclerophoma pityella (Sacc.) Died., on *Pinus strobus* (N.Y., Pa.)
Sclerophoma pythiophila (Corda) Hoehn., tip dieback of *Juniperus virginiana* (Wisc.), on cones scales of *Picea abies* (Maine, Ohio), on *Pinus banksiana* (Wisc.), on *Pinus resinosa* (Wisc.), on *Pinus strobus* (Wisc.), on *Pinus sylvestris* (Wisc.)
Septoria spadicea F. Patterson & V. Charles, needle blight of *Pinus strobus* (N.H., N.Y., Vt.)
Sirococcus conigenus (DC.) P. Cannon & Minter, on *Picea abies* (N.C.), on *Picea glauca* (N.C.), on *Picea rubens* (N.C.), on *Pinus resinosa* (Mich., Minn., Wisc.)
Sirothyriella pini-austriacae (Roum. & Fautrey) Sutton, on needles of *Pinus resinosa* (Wisc.)
Sphaeronaema pithyum Sacc., on limbs and trunks of *Pinus strobus* (N.Y.)
Sphaeropsis abietis Povah, on needles of *Abies balsamea* (Mich.)
Sphaeropsis sapinea (Fr.:Fr.) Dyko & Sutton in Sutton, on *Juniperus communis* (N.J.), on *Picea abies* (N.J.)
Stagonospora pini Grove, on foliage and twigs of *Juniperus virginiana* (Ill., Texas)
Stegonsporiopsis cenangioides (Ellis & Rothr.) Van Warmelo & Sutton, on dead limbs of *Abies balsamea* (Pa.)

MELANCONIALES

Coryneum stromatoideum (Dearn.) Sutton, on dead limbs of *Tsuga canadensis* (N.Y.)
Cryptosporium macrospermum Peck, canker on *Abies balsamea* (New England states, N.Y.)
Pestalotia stevensonii Peck, on cone scales of *Picea abies* (Pa.)
Pestalotia thujicola J.L. Maas, on shoots of *Picea abies* (Mass.)
Pestalotiopsis funerea (Desmaz.) Steyaert, on *Chamaecyparis thyoides* (Mich., N.J.), on *Juniperus communis* (Calif., Ga., Ill., Mich., N.J., S.C., Texas), on *Juniperus virginiana* (Mich., Miss., N.J., Tenn., Texas, Wisc.), on *Pinus resinosa* (Md., Tex.), on *Pinus strobus* (widespread), on *Pinus sylvestris* (widespread)
Phragmotrichum chailletii Kunze in Kunze & Schumach., on cones of *Picea rubens* (N.C., N.Y.)
Rhabdogloeopsis balsameae (J.J. Davis) Petr., needle blight on *Abies balsamea* (Wisc.)
Seimatosporium foliicola (Berk.) Shoemaker, on needles of *Pinus strobus* (D.C., Mass.)
Seiridium unicorne (Cooke & Ellis) Sutton, on foliage of *Chamaecyparis thyoides* (Ga., N.J.), on *Juniperus virginiana* (S.C.)
Truncatella angustata (Pers.) Hughes, on cones and twigs of *Picea abies* (N.Y.)
Tuberculariella ips Leach, Orr, & Christensen, blue stain on *Pinus resinosa* (Minn.)

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INDEX TO SCIENTIFIC NAMES

Note: **Boldface** indicates a name used in this treatment for a species known to occur in the wild in New York State.

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Late Eighteenth Century Vegetation of Central and Western New York State on the Basis of Original Land Survey Records

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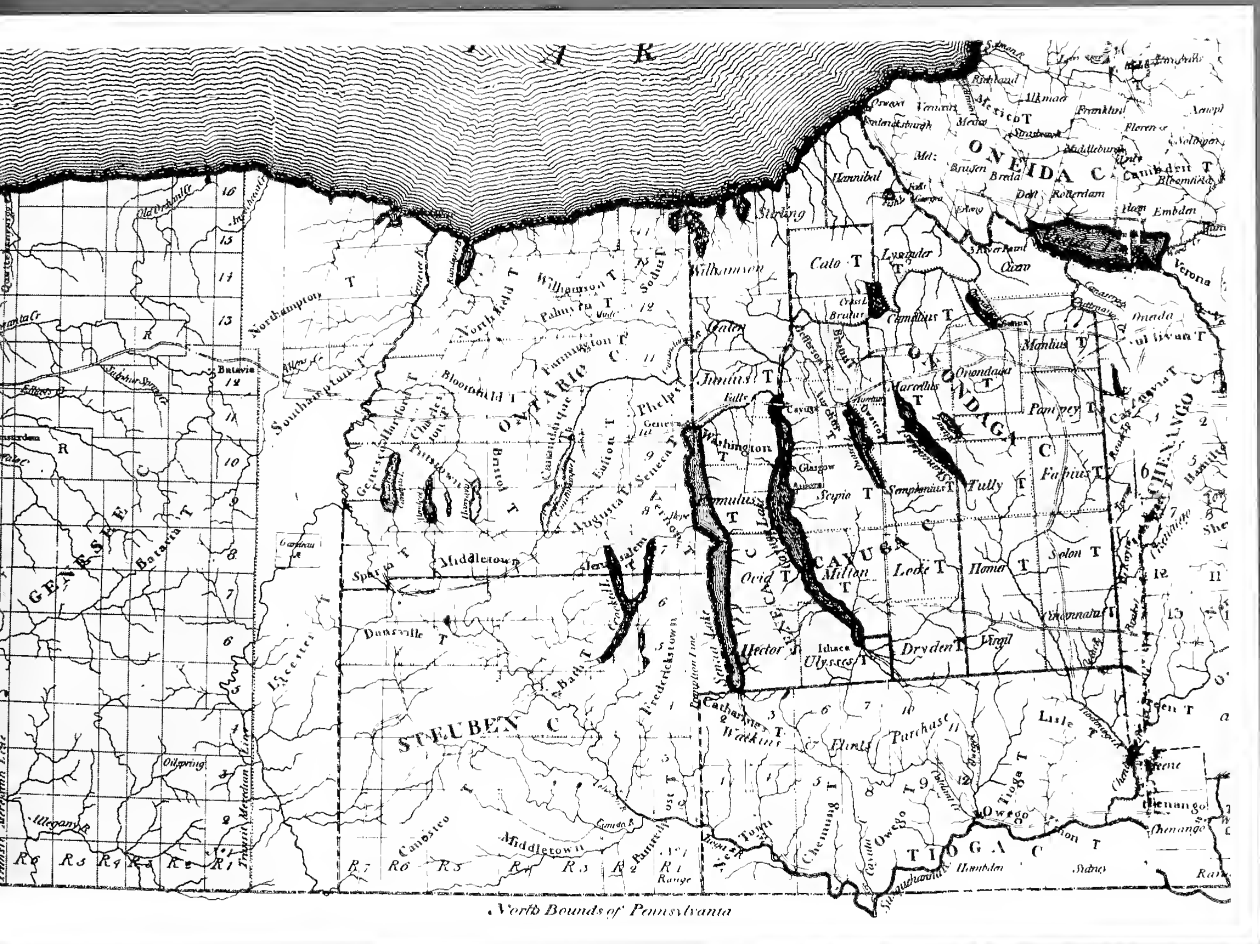

By

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Late Eighteenth Century Vegetation of Central and Western New York State on the Basis of Original Land Survey Records

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CONTENTS

PREFACE

Relatively little has been known of the forest vegetation of the northeastern United States as it existed just prior to large-scale European settlement. Several travelers' accounts describe the vegetation, but these are qualitative and not comprehensive. Notes of original rectangular land surveys provide data that allow a relatively objective picture of the vegetation to be constructed. Western New York State, a region of varied topography and geology, was one of the first areas in the United States to be surveyed in such systematic fashion.

This volume presents two studies of the late 18th century vegetation of central and western New York State. These contributions, together with the studies by Seischab (Bull. Torr. Bot. Club 117: 27-38, 1990) and Seischab and Orwig (Bull. Torr. Bot. Club 118: 117-122, 1991) provide a reasonably complete picture for most of the region.

The managing editor at the New York State Biological Survey for this New York State Museum Bulletin was Craig A. Chumbley.

Vegetation of the Central Finger Lakes Region of New York in the 1790s

P. L. Marks and Sana Gardescu

Abstract: The records made from the survey of the Military Tract in the 1790s are used to describe the vegetation that was present at that time in the central Finger Lakes region. Natural and human disturbances recorded by the surveyors, such as windfalls, burns, and cleared fields, are also reported. Woody species, forest types, and areas of open habitat are mapped at the scale of the 100 lots (each ± 1.57 km square) that made up each township, for >20 townships within the tract. Two kinds of information were used: the species of witness trees recorded at lot corners, and the surveyors' notes on trees and features of the landscape encountered along the lot boundaries.

More than 97% of the landscape was forested. Beech/maple/basswood was the predominant forest type throughout the region. Black ash swamps and other wetlands were more common in the north, on the Ontario Lowland. Oak forest was primarily in the southwest, between Seneca and Cayuga Lakes. Hemlock, cherry, and birch were common to the southeast on the Allegheny Plateau. Disturbances due to wind, fire, beavers, and people were recorded on only 1% of the lot boundaries. The windfalls occurred across the southern part of the tract, whereas burned areas were in the oak/hickory/pine region to the west. Several settlers' homes, and areas of former clearing by Native Americans, were scattered along the few roads. Other open habitats included marshes on the Lowland, and oak plains north of the Seneca River.

Introduction

Since the pioneering work of Sears (1925) and Lutz (1930), land survey records have been used repeatedly in the U.S. to convey a picture of the vegetation of a region at the time of settlement by Europeans (e.g., McIntosh 1962, Siccama 1971, Whitney 1986, Seischab 1990). Such vegetation reconstructions have been particularly valuable in areas where the vast majority of the original vegetation has been destroyed or substantially altered, making it difficult to get a sense from extant vegetation of the natural vegetation types or disturbance regime. The present paper describes the landscape in the 1790s for a part of central New York called the Military Tract, where clearing of forests for agriculture in the 1800s was extensive (e.g., Nyland *et al.* 1986, Marks and Smith 1989, Smith and Marks *in press*).

The Military Tract was created after the Revolutionary War to repay New York soldiers with grants of land and to promote settlement (Sherwood 1926). When the 28 townships within the tract were surveyed (ca. 1790-1798), the surveyors recorded the tree species growing along the boundaries and at the corners of the 100 lots in each township, and noted other features of the landscape such as swamps and windfalls.

The surveyors' records give a detailed view of the types of vegetation and disturbance found in the central Finger Lakes region 200 years ago. This information is of more than historical interest, since it improves our understanding of the origins of forest types that now occur in this region. Our study also allows a comparison of the forest types on the Allegheny Plateau and Ontario Lowland, two regions shown with differing communities on maps based on climate and soils (e.g., Bray 1930, Braun 1950). This paper complements Seischab's work, also based on survey records from the late 1700s (Seischab 1990, Seischab and Orwig 1991, and present volume), so that there is now a complete picture for much of central and western New York State.

Methods

The study area

The Military Tract covered about 6800 km^2, from Lake Ontario south onto the Allegheny Plateau, and from Seneca Lake in the west to Oneida Lake in the east. The Tract was divided into 28 townships (Fig. 1). Relief is greater on the southeastern portion of the Tract, where some hills exceed 600 m in elevation and slopes are often >10%. The land between the Finger Lakes is level or rolling plains (Thompson 1966). To the north are the drumlins on the Ontario Lowland, where elevations are about 120 m.

In both the southern part of the Military Tract and at the northern end on Lake Ontario the soils are acidic, developed on glacial till (Cline 1970). Across the mid-region soils are more calcareous, developed on glacial till or on sediments from glacial lakes. Alluvial soils are found in stream valleys on the Plateau and on the Ontario Lowland. There are many swampy areas, both in valleys and uplands.

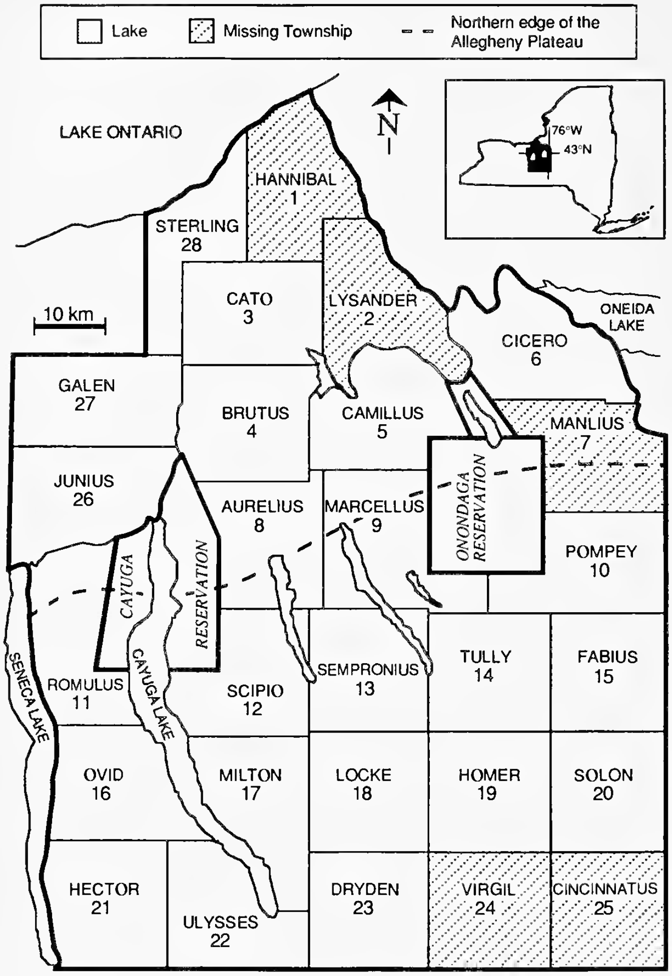


Fig. 1. Map of the 28 townships in the Military Tract. The two Indian Reservations in the region are also shown. Inset shows the location of the tract within New York State. The survey records of five townships were missing (diagonal lines). The boundary between the Ontario Lowland and the Allegheny Plateau (dashed line) is based on Fenneman (1938).

The climate is humid continental, with cold snowy winters (Thompson 1966). From the Finger Lakes north to Lake Ontario is a region of warm dry summers. To the south and southeast of the lakes, summers are cool and wet. Mean annual precipitation is about 750 to 1000 mm (Cline 1970). The average length of growing season ranges from about 135 days in the south to 180 days at Lake Ontario (Cline 1970).

Survey records

At the State Archives in Albany the senior author consulted the handwritten survey notes from the 1790s (Accession #94, vols. 24-27). All information pertinent to vegetation, topography, soils, and disturbance was read into a tape recorder, transcribed onto paper, and entered into a computer. For five townships (Table 1, Fig. 1) the survey records could not be found in the State Archives, local historical societies, or county clerks' offices. We do not know whether the records for these townships were lost or destroyed, or whether they may be preserved elsewhere. Copies of the surveyors' maps for all 28 of the townships were available at the State Archives.

Some difficulty was encountered in deciphering the handwriting of the records. The notes from one township (Solon) appeared to be the original notes written in the field at the time of survey, based on the rough handwriting, the many smudged ink spots, and the personal comments irrelevant to the survey *per se* (e.g., "Saturday, 25 June 1791: Laid still in camp for our boys to bathe."). In contrast, the perfect appearance of the notes from the remaining townships suggested that they were copied from the actual field notes. The eighteenth-century penmanship produced ambiguities (e.g., "fine" swamp vs. "pine" swamp, "butternut" vs. "bitternut"), but the number of such instances was small.

Data on woody species

Sample size

Each of the 28 townships in the Military Tract was divided into 100 lots, which were 600 acres (242.8 ha) each. Most lots were square, with the length of a side (a "bounds") slightly less than 1 mile (1.57 km; typically 78 chains, where 1 chain = 66 ft). Two kinds of information about vegetation were routinely provided by the surveyors: one witness tree at each lot corner, and brief lists of woody species encountered along the lot boundary.

In addition to the five townships for which we could not find the survey records, two (Camillus and Cicero) had witness information but no notes about boundary vegetation (Table 1, Fig. 1).

Table 1. Summary of townships, dates surveyed, and surveyors, where known. Records from five townships were not available. In Townships 5 and 6, witness trees were recorded but lot boundaries were not described. The spelling of names sometimes varied.

	Number	Township	Date	Surveyor(s)
Missing	1	Lysander	—	—
Missing	2	Hannibal	—	—
	3	Cato	—	William Ewing
	4	Brutus	—	Jacob Hart and Joseph Annin
[Witness]	5	Camillus	—	Barry Barton
[Witness]	6	Cicero	—	Boris Curtis
Missing	7	Manlius	—	—
	8	Aurelius	1790	—
	9	Marcellus	—	Jacob Hart and Joseph Annin
	10	Pompey	1791	—
	11	Romulus	—	—
	12	Scipio	—	—
	13	Sempronius	1791	Elisha Durkee
	14	Tully	1791	Jacob Hart
	15	Fabius	—	Joseph Annin
	16	Ovid	1790	Peter G. Cuddebach
	17	Milton	1790	Jacob Hart
	18	Locke	1790	Abraham Hardenbergh
	19	Homer	ca. 1790	Jacob Hart
	20	Solon	1791	Moses DeWitt
	21	Hector	1790	Sherman Nicholson
	22	Ulysses	1790	Moses DeWitt
	23	Dryden	1790-91	John Konkle
Missing	24	Virgil	1791	Moses DeWitt
Missing	25	Cincinnatus	1791	Moses DeWitt
	26	Junius	—	—
	27	Galen	1797	Joseph Annin
	28	Stirling [Sterling]	1798	Joseph Annin

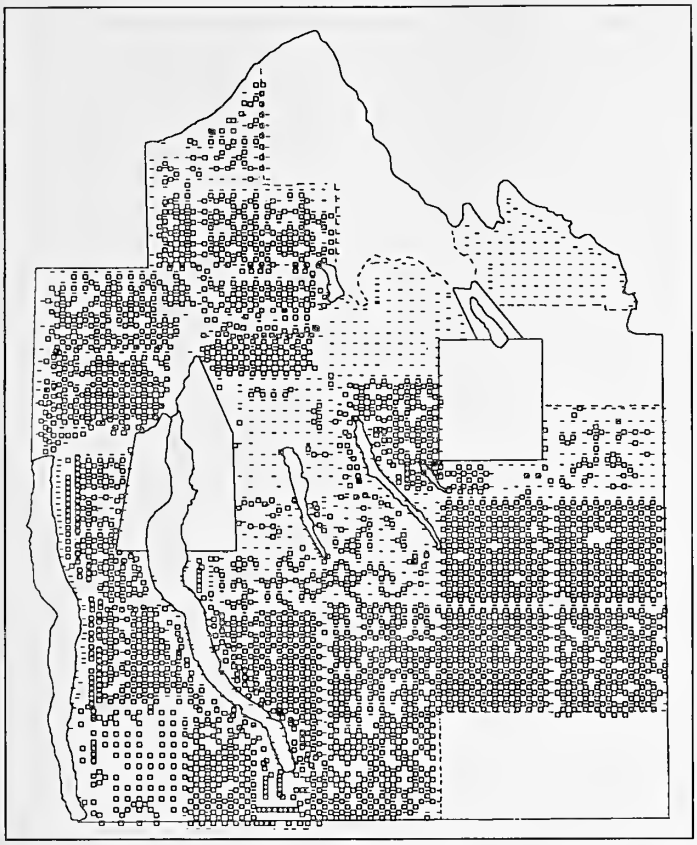


Fig. 2. Map showing which townships had more information on vegetation. Each bounds (i.e., one side of a 600-acre lot) is mapped at the center of the side of the lot. Each square represents a bounds where woody species were recorded in the surveyors' notes. Thus, where all four sides of a lot were described, they are shown as four squares. Dashes represent the witness corners where surveyors recorded the species of tree or sapling. Dashed lines mark the borders of townships with missing survey records.

Thus, out of 28 townships there were 23 for which we had witness data, covering about 5600 km^2, and 21 with boundary descriptions, or about 5100 km^2. With 100 lots per township, the potential sample size for witness trees would be about 2300. For the 21 townships with lot boundary information, there potentially could be about 4200 lot bounds, or 200 bounds per township, since the north and west sides of most lots were the south and east sides of adjacent lots. Species were not always recorded along bounds or at witness corners, and some lots were missing from the records, so the number of witness trees ranged from 12 to 118 per township, and the number of bounds from 23 to 179. However, most townships had data for >80 witness corners and >100 bounds. Total sample sizes were 1,992 witness trees and 2764 bounds in which woody species were recorded (Fig. 2).

Witness trees

Normally a single witness tree or sapling was recorded at each lot corner. Witness data were treated as presence/absence data, giving percentage occurrence of each species relative to the total number of corners at which species were recorded. A wooden stake was set at each lot corner, and some surveyors indicated the species of stake. We summarized this information on the assumption that the stakes were cut from the saplings at hand and thus may provide information about the understory.

Boundary lines

The amount of description of the boundary lines varied considerably from one surveyor to another. At one extreme, information consisted of a brief list of tree species, for example:

"Stirling [sic]... Lot 13: south bounds, heading east:
39 [chains] — brook;
72/50 [chains and links] — timber beech and maple, to a post 4 links west of a maple tree marked."

At the other extreme, detailed lists of trees were provided, sometimes understory herbs were mentioned, and major changes in species composition were noted, with the distance at each such change, as well as the beginning and end of swamps, marshes, or areas of blowdown or fire; for example:

"Fabius... Lot 7: south bounds beginning at the southwest corner, thence east:
15 — entered a swamp timbered with tamarack and black alder;
35 — out of the swamp on beech and hemlock land;
45 — a large brook running southerly and low ground covered with black alder;
50 — a brook running southerly and out of the low land into beech, maple, linden, and hemlock;
73 — set a post; marked a beech tree southwesterly 25 links. Land from the swamp good; timber as before."

Each lot bounds (i.e., each side) was treated as a line intercept sample (Seischab 1990). For each species, we used the distance along the boundaries as a measure of abundance. In the example above, tamarack occurred over a distance of 20 chains (from 15 to 35 chains). For each species, we calculated the number of lot bounds in which it was recorded and the sum of the distances of individual occurrences. These were summarized relative to the total number (2764) and total distance (4523 km) of bounds in which any woody species were recorded.

Although the majority of bounds were 1.55-1.61 km, they ranged from 0.5 to 5 km, so we also calculated the relative distance of a taxon along each bounds as a percent of that bounds' length. In the many cases where species were listed when the surveyor reached the end of the bounds, they all were given a value of 100% of bounds length. Conservatively, we attached no significance to the order of listing of species in the many cases where more than one species was recorded for a given lot boundary. Our approach differed in this regard from that used by Seischab (1990, and present volume).

Plateau vs. Lowland

To compare relative species abundance on the Allegheny Plateau and the Ontario Lowland, we mapped the location of Fenneman's (1938) physiographic boundary (see Fig. 1) onto a map of the Military Tract which shows the lots (DeWitt's State Map of New York, 1st sheet, 1792). We assigned each lot bounds and corner to one of the two regions, and for each of the common woody taxa, calculated their summed distances along lot bounds relative to the total distance within the region (3323 km for Plateau, 1192 for Lowland). Relative witness tree abundance was also summarized.

Interpretation of species names

There was some uncertainty in interpreting the surveyors' names for species of trees and shrubs. Names listed together in Table 2 indicate ones treated as synonyms for our analyses. For example, since a surveyor could enter "a black alder swamp" and then leave "the alder swamp," we treated "black alder" and "alder" as one taxon. Similarly, we grouped "white ash" with "ash," and "white pine" with "pine." We consulted a number of floras for the historical usage of common names and for the range and habitat of potential species (Torrey 1843, Paine 1865, Clute 1898, Goodrich 1912, Britton and Brown 1913, Wiegand and Eames 1926, Gleason 1952, Peattie 1966, Fernald 1970, Little 1971). Latin nomenclature follows Mitchell (1986).

Surveyors frequently used the term "maple." They also used "sugar," "sugar tree," "sugar maple," and "hard maple," which were clearly references to *Acer saccharum*. Given the distinct difference among surveyors visible at the scale of townships in the use of "maple" vs. "sugar" or "hard" maple (Figs. 3.1, 3.2), it was clear that much of the "maple" included *A. saccharum*, and therefore for most analyses these three terms were treated as a single "maple" taxon.

Surveyors also differed in number of mentions of "soft" and "white" maple, both of which were usually recorded in swamps. A reasonable interpretation is that "soft maple" (mentioned 25 times) was *A. rubrum*, which today is called soft maple as well as red maple, whereas "white maple" (used 11 times) and the one "swamp maple" referred to *Acer saccharinum*. Therefore, we treated "soft maple" as a separate taxon from "white" or "swamp" maple in the analyses. It is difficult to believe that the ecologically wide-ranging *A. rubrum* was encountered so rarely by the surveyors, as it is found today in both swamps and uplands throughout the region, so it is likely that "maple" included *A. rubrum* as well as *A. saccharum*. Perhaps the frequency of "hard" and "soft" maples recorded by the one surveyor who never used the term "maple" (Cuddebach, in the township of Ovid) reflected the relative abundance of *A. saccharum* and *A. rubrum*: only 6% were "soft." However, to keep "soft" separate from "hard," we did not include "soft maple" in our taxon group made up of "maple," "hard maple," and "sugar maple."

For most analyses the 19 occurrences of "black birch" were merged with "birch," since it was unclear how many of the 122 "birch" were *Betula lenta* (black) or *B. alleghanensis* (yellow). The term "yellow" birch was not used by any surveyor, although the species is common in the region today. "White birch," mentioned twice, could refer to *Betula populifolia* or to *B. papyrifera*. The single "paper birch" witness tree was probably the latter species, based on common names listed in Britton and Brown (1913).

The oaks were frequently not differentiated in the survey records. One surveyor recorded "black oak," "red oak," and "white oak," but only rarely "oak," but most surveyors primarily used "oak." Since even these surveyors distinguished "black" from "white" as witness trees, both species were probably included in "oak" recorded along bounds. "Black oak" was mentioned almost seven times more often than "red" oak. Was *Quercus velutina* so much more common than *Q. rubra* in 1790, unlike today? Or was "red oak" *Q. coccinea* (scarlet oak)? Because "red oak" often co-occurred with mesophytic species (e.g., maple, basswood, beech) this name would have referred to *Q. rubra*, not *Q. coccinea*. And since only three surveyors used "red," it is likely that the other surveyors included *Q. rubra* with *Q. velutina* in "black oak" and "oak." For the analysis of community types (discussed later), which can produce artificial splits among types if synonymous taxa are separated, we grouped "black," "red," and "oak." Although white oak, *Q. alba*, was probably also included in "oak," we kept "white" oak as a separate taxon because surveyors listed "black" and "white" oak as distinct species in 138 of the bounds.

We considered "scrubby" and "scrubby black" oaks to be stunted growth rather than species names, as opposed to "scrub oak," which could be *Q. ilicifolia*. Although Wiegand and Eames (1926) did not list this species in the flora of the Cayuga Lake basin, *Q. ilicifolia* was present north of Syracuse in the 1800s (Goodrich 1912).

"Whitewood" apparently referred to *Liriodendron* rather than *Tilia*, since "basswood" or "linden" were often listed in the same bounds with "whitewood." It was unlikely to refer to cottonwood, *Populus deltoides*, which can also be called whitewood (Peattie 1966), both because the surveyors did not record "whitewood" on riverbanks, and because they sometimes used the term "whitewood (popple)." Popple is a name for *Liriodendron* and the aspens (*P. grandidentata* and *P. tremuloides*), but not *P. deltoides* (Peattie 1966). The names tulip poplar, yellow poplar, and cottonwood were not used in the survey records. Use of the terms "whitewood (poplar)" and "popple alias whitewood" suggested that *Liriodendron* may sometimes have been included in "poplar" and "popple." The "poplar" on ridges with oak or chestnut would have been *P. grandidentata*. All but one of the mentions of "aspen" were by one surveyor, who never used "poplar." Since there clearly was surveyor bias in the use of these names, and since *P. grandidentata* and *P. tremuloides* were known as aspen, poplar, and popple (Peattie 1966), we treated these three synonymously (Table 2). Any mentions that included the term "whitewood," including "popple alias whitewood," we treated as *Liriodendron*. But because of this ambiguity, all of these were combined for the community analysis described below.

Habitat was a clue to species identity in several cases. Since all mentions of "spruce" were in swamps, this would have been *Picea mariana* rather than the upland species *P. rubens*. "Spruce" perhaps also included *P. glauca*, which Beauchamp (1923) found with *P. mariana* in a swamp in southern Lysander (one of the townships for which we did not have survey records). All of the "cedar" occurred in swamps, marshes, or "low" "swampy" land, and therefore would have been white cedar, *Thuja occidentalis*. The one "red cedar" would have been *Juniperus*. The "pond of lowrells" was probably bog laurel, *Kalmia polifolia*. "Huckle-berry" occurred in an area of intermixed swamps and sandy patches just north of Seneca Lake, the habitat and location reported for *Gaylussacia baccata* (Wiegand and Eames 1926).

Table 2. Names of woody species from the survey records, and the likely equivalent genera and species. Surveyors' names listed together indicate how we grouped them for analysis. Uncertain identifications are in brackets. See text for sources consulted. Latin nomenclature follows Mitchell (1986).

Surveyors' names	Likely species	
Maple	*Acer*	*saccharum, rubrum, saccharinum*
Soft maple	*Acer*	*rubrum, [saccharinum]*
White maple, Swamp maple	*Acer*	*saccharinum, [rubrum]*
Hard maple, Sugar maple, Sugar	*Acer*	*saccharum*
Alder, Black alder	*Alnus*	*incana, Ilex verticillata*
June, Juneberry, Servis	*Amelanchier*	*arborea*
Birch	*Betula*	*lenta, alleghanensis*
Black birch	*Betula*	*lenta*
White birch, Paper birch	*Betula*	*papyrifera, [populifolia]*
Hickory, Bitternut	*Carya*	*cordiformis, glabra, ovata*
Chestnut	*Castanea*	*dentata*
Dogwood	*Cornus*	*florida*
Hazel, Hazelbushes	*Corylus*	*americana, cornuta*
Thorn, Thorn bush/tree, Thorns	*Crataegus,*	*[Rosa]*
Beech	*Fagus*	*grandifolia*
Ash, White ash	*Fraxinus*	*americana, [nigra, pennsylvanica]*
Black ash	*Fraxinus*	*nigra*
Water ash	*[Fraxinus*	*pennsylvanica* or *Acer negundo]*
Huckle-berry	*Gaylussacia*	*baccata*
Butternut, White walnut	*Juglans*	*cinerea*
Walnut, Black walnut	*Juglans*	*nigra*
Red cedar	*Juniperus*	*virginiana*
Lowrell	*Kalmia*	*polifolia*
Tamarack	*Larix*	*laricina*
Whitewood	*Liriodendron*	*tulipifera*
Mulberry	*Morus*	*rubra*
Pepperidge	*Nyssa*	*sylvatica*
Ironwood, Hornbeam, Hard beam	*Ostrya*	*virginiana, Carpinus caroliniana*
Spruce	*Picea*	*mariana*
Pitch pine	*Pinus*	*rigida*
Pine, White pine	*Pinus*	*strobus, resinosa*
Buttonwood	*Platanus*	*occidentalis*
Poplar, Aspen, Popple	*Populus*	*tremuloides, grandidentata, [deltoides]*
Plum, Plumb	*Prunus*	*nigra*
Cherry, Wild cherry	*Prunus*	*serotina*
Oak	*Quercus*	*rubra, alba, velutina [montana, coccinea]*
White oak	*Quercus*	*alba*
Swamp oak, Swamp white oak	*Quercus*	*bicolor*
Scrub oak	*Quercus*	*[ilicifolia]*
Chestnut oak, Rock oak	*Quercus*	*montana*
Red oak	*Quercus*	*rubra*
Black oak	*Quercus*	*velutina, rubra*
Currants	*Ribes*	
Briers	*Rubus,*	*[Rosa]*
Willow	*Salix*	
Sassafras	*Sassafras*	*albidum*
Dogberry	*[Sorbus*	*americana, Cornus sericea,* or *Aronia arbutifolia]*
Cedar	*Thuja*	*occidentalis*
Linden, Lyn, Lime, Basswood, Bass	*Tilia*	*americana*
Swamp shuomach	*Toxicodendron*	*vernix*
Hemlock	*Tsuga*	*canadensis*
Elm, White elm	*Ulmus*	*americana, [rubra]*
Red elm	*Ulmus*	*rubra*
Cranberry	*Vaccinium*	*macrocarpon, oxycoccos*

Vegetation types

To map the distribution of forest communities in the Military Tract, and to see how the groups of species were related, the TWINSPAN program (Hill 1979) was used to produce a workable number of types from the large dataset. This program orders data from vegetation samples such that samples with similar species composition are placed close to one another. The listing of samples is repeatedly divided dichotomously, keeping samples with similar composition together. Two dendrograms showing relationships among samples are created: one for community types and one for species.

The data used in the TWINSPAN analysis were from the boundary descriptions, with each side of the lot (each bounds) treated as a single vegetation sample. For each taxon occurring in a bounds, we used its relative distance along the bounds (i.e., percent of that bounds' length) as a measure of abundance. The total sample size was 2466 bounds; bounds with incomplete distance information (e.g., in the township of Hector) were excluded from the analysis.

The TWINSPAN analysis was based on 23 woody taxa. Species mentioned in <9 bounds were excluded. Several species names used by different surveyors, which appeared to include the same taxa, were grouped in order to avoid artificial divisions of vegetation types: (a) "maple" with "hard" or "sugar" maple, (b) "oak" with "black" and "red" oak, (c) "birch" with "black" birch, and (d) "poplar" with "popple," "aspen," "whitewood," and combinations like "whitewood (poplar)."

Other boundary information

The surveyors also recorded other kinds of information about the landscape, such as swamps, marshes, windfalls, and clearings. In some bounds these were mentioned without listing any species, so the total sample size was greater than for the woody species analysis. We used 6433 km as the total distance of surveyed bounds. This was based on 4100 bounds, with a median size of 1.569 km, since each of the townships for which we had boundary descriptions had about 200 bounds (21 x 200 = 4200), but half of the records from Hector were missing. Information on swamps, disturbance, and open areas was summarized relative to these values.

Soils and topography were often described, for example "poor soil," "good land," or "ridgy." For the bounds in each of the community types produced by TWINSPAN, we compared the number of times the various descriptive terms were used. We ignored terms that clearly referred to a section of bounds that was not part of that vegetation type, for instance the comment "land between the swamps is good" for a bounds in the *Black ash swamp* type.

Maps

Many of the results were best displayed as maps of spatial distribution within the Military Tract. An arbitrary X-Y coordinate system was used, based on the surveyors' township maps (copied at a scale of 1.12 km per cm). Because witness trees were recorded only at lot corners, it was a simple matter to assign coordinates to each witness tree. However, since boundary information was recorded from near the initial corner to near the final corner and everywhere in between, mapping the boundary data was much less straightforward. The boundary data (occurrenees of trees, swamps, etc.) were mapped at the midpoint of the bounds, which considerably simplified the procedure for assigning coordinates to each piece of boundary information (nearly 10,000 records) and allowed both witness and boundary information to be shown on the same map. The outlines of lakes and of the Military Tract as a whole were based on DeWitt's 1792 map (State map of New York, 1st sheet). Our maps were produced in the computer facility of the Geological Sciences Department at Cornell, using a program written by S. Gallow for the VAX computer.

To understand the relationship between the landscape and the various disturbances and open areas mentioned in the records, we marked their locations on 15-minute U.S.G.S. topographic maps. We were guided by the rivers and lakes on the surveyors' maps, by modern small roads, which sometimes follow lot edges, and for townships in Tompkins County, by a map from 1866 (Wehle 1973). At this scale, the topographie information (along with species composition and the spatial distribution of windfalls and other disturbances) allowed us to interpret the "thickets of saplings," "thick underbrush," and "scrubby" vegetation.

To show where humans were likely to have had effects on the landscape, we also mapped roads that were present in the 1790s. Some surveyors' township maps showed the positions of the roads; for other townships we used the boundary descriptions, and mapped the locations where surveyors recorded roads that intersected lot bounds. The usual term used was "road," but there were also a few mentions of "Indian foot path," "horse road," and "cart road." In townships where surveyors did not map any roads, and where roads were recorded in the descriptions of certain bounds but not on the adjacent lots, we used two maps by Simeon DeWitt (Map 103C in Cook 1887, and the 1st sheet of the 1792 state map) to fill in the gaps. DeWitt's Map 103C was based on a surveyor's report made during General Sullivan's military campaign through this region in 1779. His 1792 state map includes a road that may post-date the survey, since it appears to run along township and lot boundaries, and was not mentioned in the survey notes.

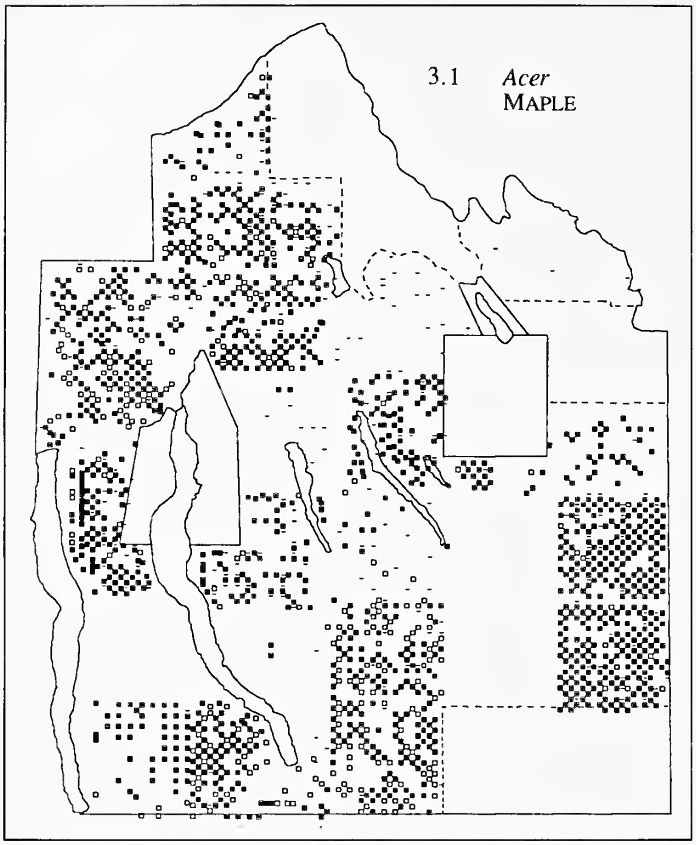
Results

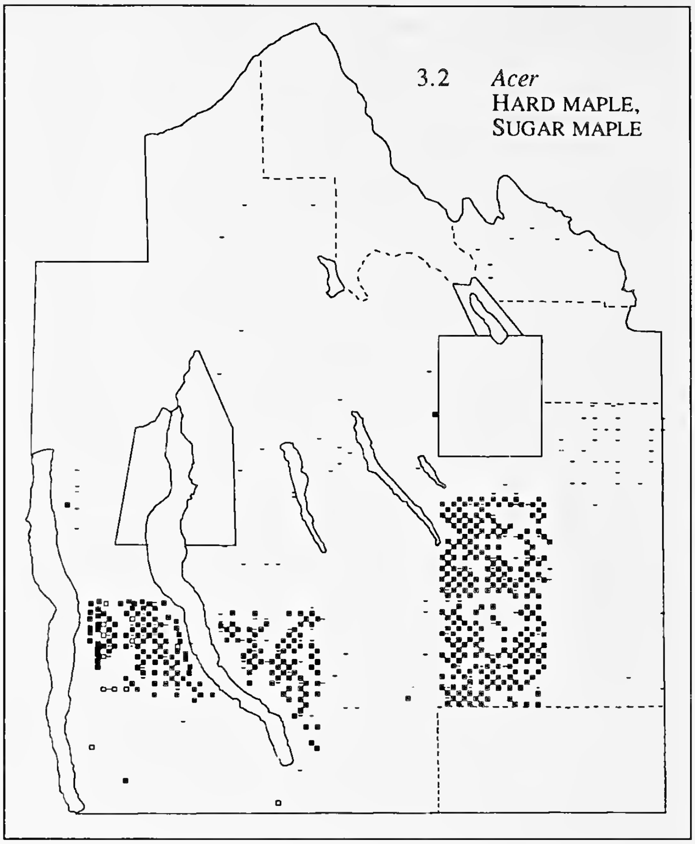
Woody species

More than 50 species of trees and shrubs were mentioned by the surveyors in the course of describing 2764 lot bounds (Table 3). Surveyors usually listed only two to four species in each bounds (75% of the time); more than 6 species were listed in only 2% of the bounds, and the maximum was 11 co-occurring species. Thirty-six taxa were recorded as witness trees in a total of 1,992 lot corners (Table 3). Several of the entries in Table 3

Table 3. Abundances of woody taxa mentioned in the survey notes, along lot bounds and at witness corners. Line divides the common taxa (recorded in >15 bounds) from minor species (in <9). Two measures of bounds abundance are shown: the summed distances along which the taxon was recorded, relative to the total distance of all bounds (4523 km), and the number of bounds, relative to the total number (2764). These totals exclude bounds where the surveyors did not record any woody species. Percents do not sum to 100 because species co-occurred. For witness corners, abundances are relative to the total number of corners with species recorded; percents sum to 100.

	BOUNDS		WITNESS CORNERS	
Species	Distance (% of 4523 km)	Number (% of 2764)	Trees and saplings (% of 1992)	Stakes (% of 483)
Beech	60.7%	72.0%	46.5%	36.6%
Maple	41.9	51.9	11.4	5.4
Linden/Basswood	41.0	47.3	3.9	6.6
Hard maple/Sugar maple	15.1	15.7	8.3	16.6
Hemlock	12.9	19.2	4.9	1.2
Ash/White ash	11.3	14.0	2.5	3.5
Elm/White elm	10.8	13.4	2.0	3.5
Oak	8.8	10.7	0.05	0.6
Hickory/Bitternut	6.8	7.9	1.7	5.6
White oak	6.5	7.9	4.3	0.4
Pine/White pine	6.3	9.6	1.4	1.0
Black oak	5.1	5.6	1.9	1.4
Chestnut	3.9	5.5	0.6	1.2
Cherry	3.6	4.3	0.2	0.2
Black ash	2.9	12.1	3.2	0.4
Birch	1.9	2.7	2.3	0.4
Butternut/White walnut	1.7	2.0	0.4	0.6
Alder/Black alder	0.8	3.0	0.05	0.6
Walnut/Black walnut	0.8	1.0	.	.
Ironwood/Hornbeam	0.5	0.7	1.6	10.4
Red oak	0.5	0.9	0.2	0.2
Poplar/Aspen/Popple	0.5	0.9	0.6	0.4
Cedar	0.5	1.3	.	.
Whitewood	0.4	0.6	0.1	0.2
Tamarack	0.4	1.6	0.3	0.2
Pitch pine	0.3	0.6	0.3	.
Black birch	0.2	0.6	0.2	.
Soft maple	0.2	0.7	0.3	0.4
Swamp oak/Swamp white oak	0.1	0.2	.	.
White maple/Swamp maple	0.1	0.3	0.3	.
Thorn/Thorns	0.1	0.3	.	0.2
Scrub oak	0.07	0.3	.	.
Dogwood	0.07	0.1	.	0.6
Willow	0.06	0.2	0.05	.
Briers	0.05	0.2	.	.
Spruce	0.05	0.2	.	.
Hazel/Hazel bushes	0.04	0.07	.	.
Chestnut oak/Rock oak	0.04	0.1	0.1	.
Plum	0.04	0.07	.	.
White birch/Paper birch	0.03	0.07	0.05	.
Currants	0.03	0.1	.	.
Buttonwood [i.e., sycamore]	0.03	0.1	0.3	.
Huckle-berry	0.03	0.07	.	.
Sassafras	0.01	0.04	.	0.2
Cranberry	0.01	0.1	.	.
June/Juneberry/Servis	0.01	0.04	0.2	0.6
Water ash	0.007	0.04	.	.
Pepperidge	0.001	0.04	0.05	.
Lowrells [i.e., laurel]	0.0004	0.04	.	.
Mulberry	0.0004	0.04	.	.
Red elm	.	.	0.1	0.2
Red cedar	.	.	0.05	.
Swamp shuomach	.	.	0.05	.
Dogberry	.	.	.	0.2





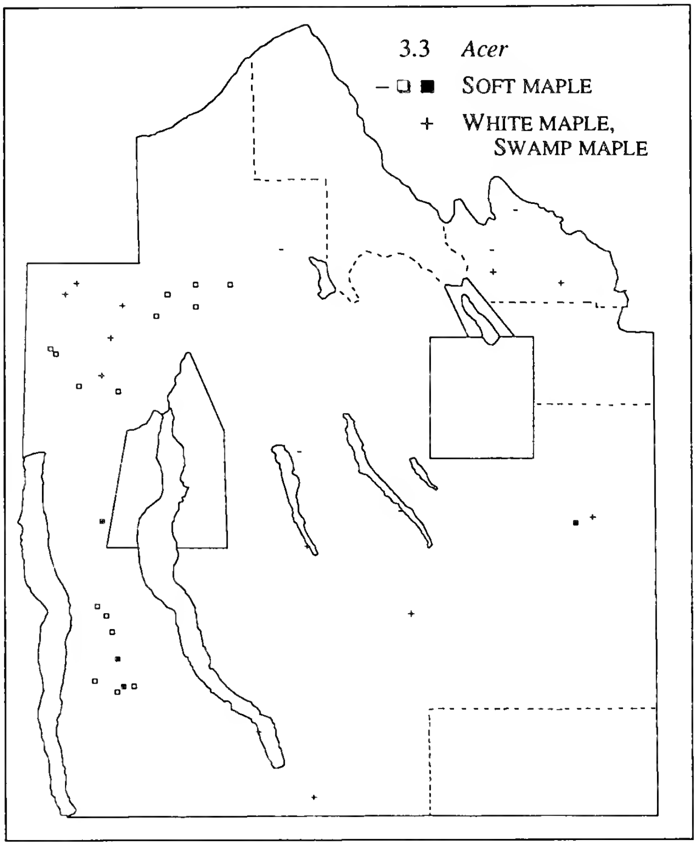
Figs. 3.1-3.27. Maps of the occurrences of the common woody taxa in the Military Tract, as recorded by the surveyors. The taxa are ordered alphabetically by genus (as in Table 2). Dashes represent witness trees or saplings at the lot corners. Boundary information is mapped at two levels of abundance: open squares represent bounds where taxa were recorded along <50% of the length; filled squares, ≥50% of the bounds length. Note that apparent gaps in species distributions should be compared with Figure 2 to see if these are areas where no species were recorded. For comparison with soft maple, "white" and "swamp" maple are also shown (same symbol for bounds or witness).

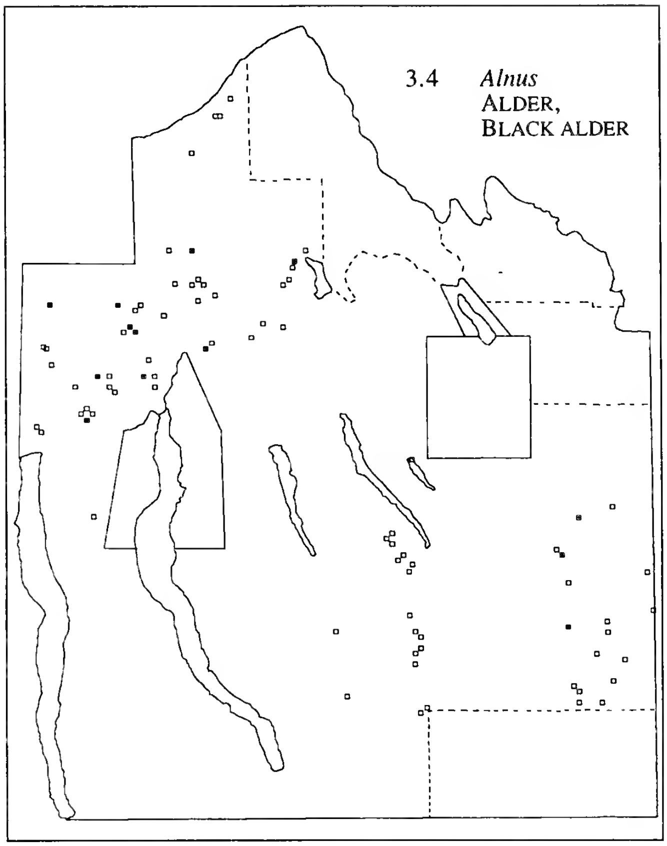
represent more than one species: "ironwood" presumably included both *Carpinus* and *Ostrya*, and "hickory" would have included bitternut, shagbark and pignut; only one "bitternut" was mentioned by name. Half of the taxa were mentioned <15 times (Table 3); these minor species are discussed later.

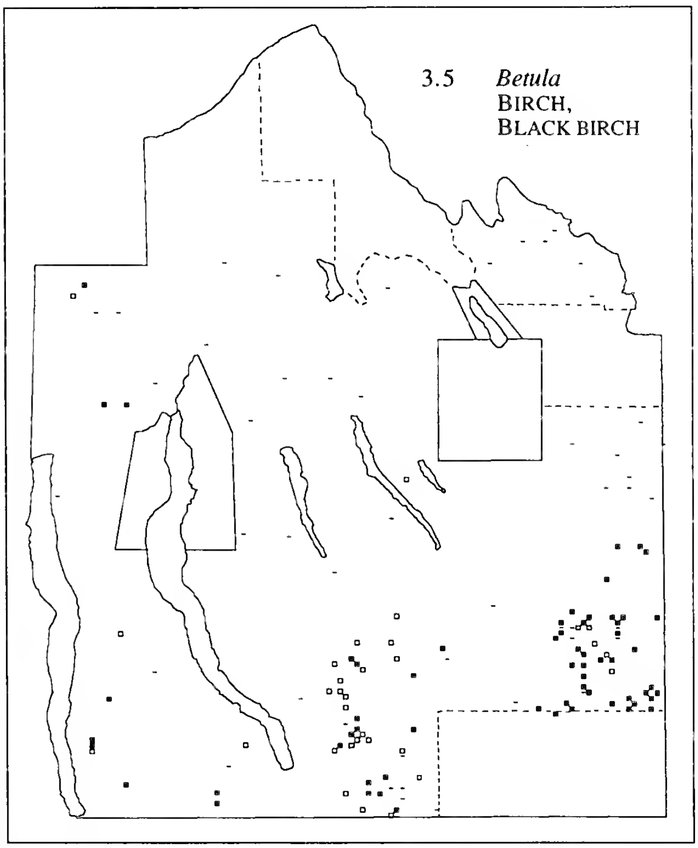
Geographic distributions of the occurrences of tree taxa mentioned in the survey notes are given in Fig. 3. Beech was the most common woody species encountered by the surveyors (Table 3, Fig. 3.8). Beech occurred in 72% of the lot bounds, and along 61% of the total distance (with other species or alone). Beech was also the most abundant species as witness tree or as wood for witness corner stakes.

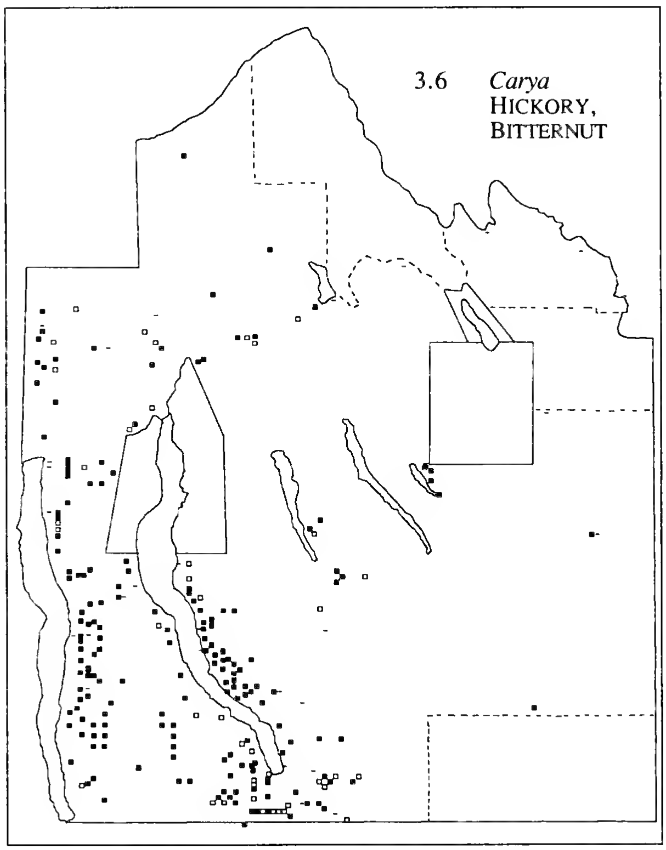
The rank order of species based on the number of bounds was reasonably congruent with the order based on total boundary distance (Table 3). The exceptions, such as black ash, recorded in 12% of the bounds but only 3% of the distance, were taxa that often occurred on only a small distance along individual bounds. Taxa with the lowest relative bounds lengths (Fig. 4) were all swamp species, including black ash, alder, and tamarack (Table 4 lists species recorded in swamps). Wetland taxa were seldom recorded along entire lot bounds; such bounds were either described as swamps without mentioning species, or were not traversed (e.g., "through bad swampy land to a marsh, which I left being impracticable to pass"). The median distance in swamp, for bounds in which it was recorded, was quite small: 0.24 km (Table 4). Since most bounds were 1.6 km, this created the differences in relative bounds number and relative total distance (Table 3) for the species found mainly in swamps. Similarly, species of dry ridges such as chestnut and pitch pine also had low relative bounds lengths (Fig. 4). In contrast, virtually all of the common upland species, in bounds where they were listed, were usually recorded for the entire length of the bounds (medians = 100%; Fig. 4).

For the lot boundary data, beech, maple (presumably mostly sugar maple), and linden (i.e., basswood) were overwhelmingly the most abundant species, whether based on occurrence or distance (Table 3, Figs. 3.8, 3.1, 3.25). The same was not true for the witness data. In the boundary data, maple and hard maple together were nearly as abundant as beech, whereas in the witness data beech was more than twice as abundant as maple plus hard maple; 47% vs. 20% (Table 3). No other species exceeded 5% of the witness trees: hemlock was third in abundance at 4.9% and white oak was fourth at 4.3%. Only a single "oak" witness tree was recorded, although it was common on bounds; as mentioned above, at lot corners the surveyors specified oaks as white or black. The total frequencies for all species of oak were 6.5% of the witness trees and 19.4% of the number of bounds, similar to hemlock (4.9% of witness, 19.2% of bounds). Only 3.9% of the witness trees were linden, perhaps reflecting surveyor bias, a more clumped distribution than for beech and maple, or a lower









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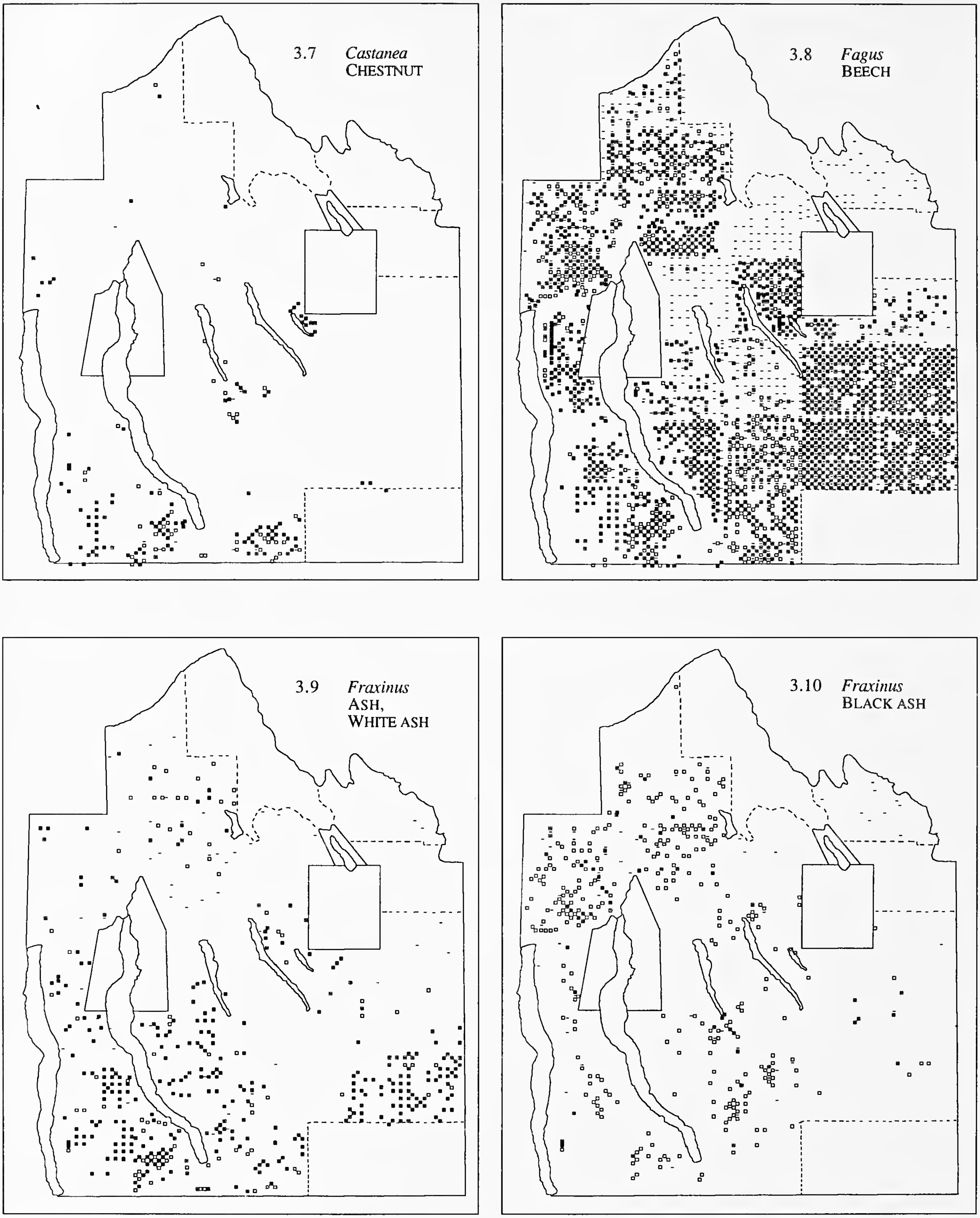

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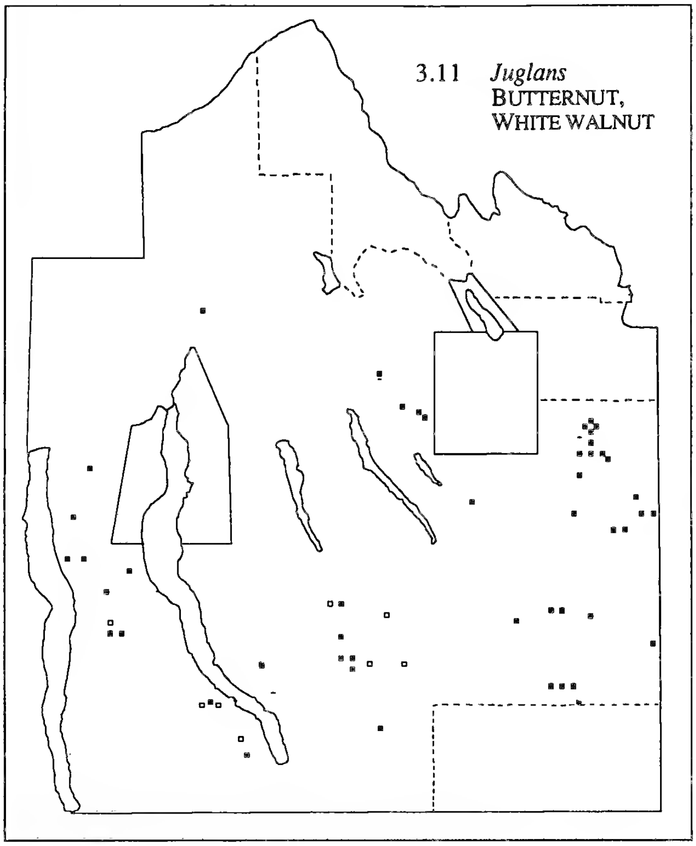

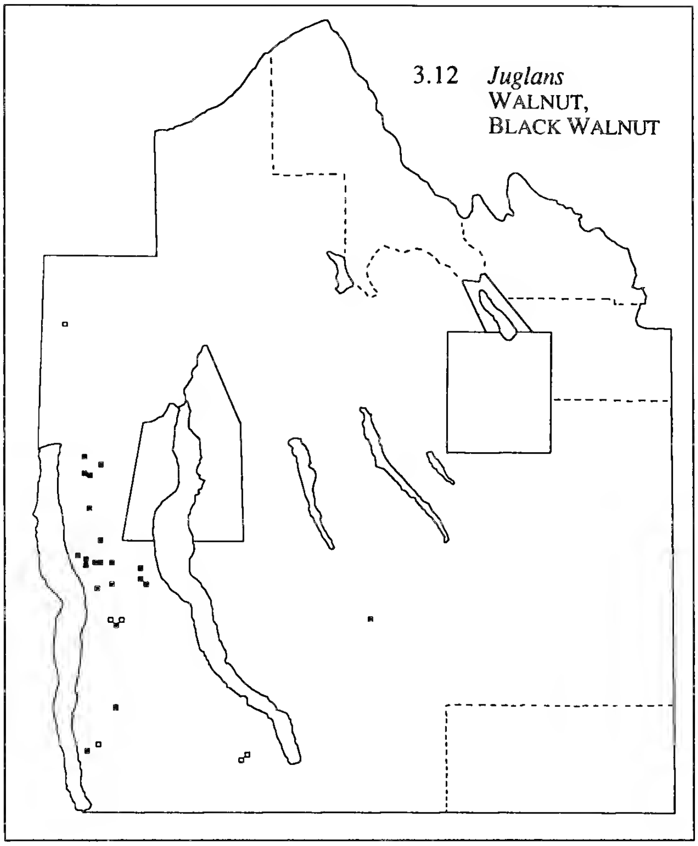

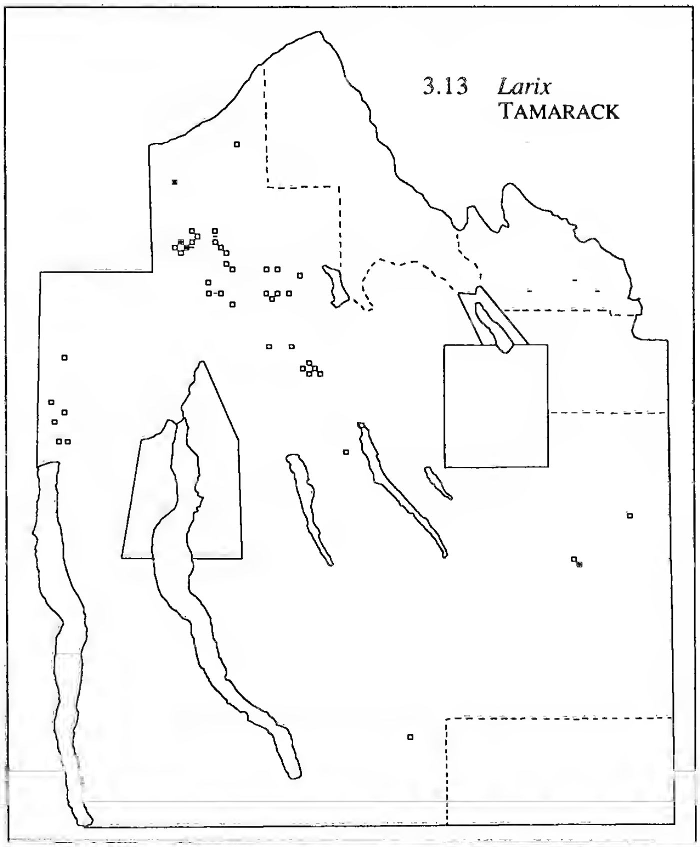

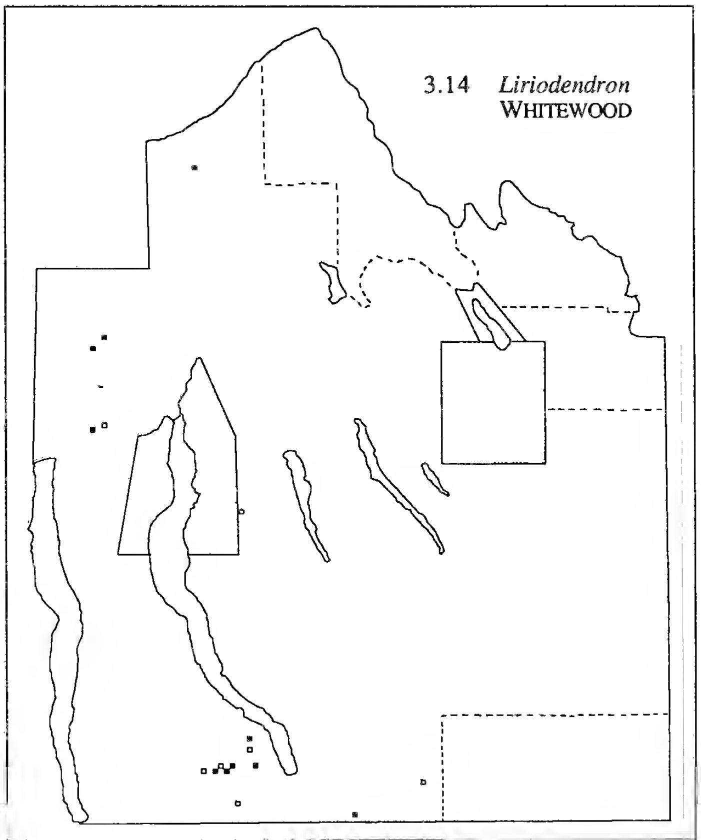

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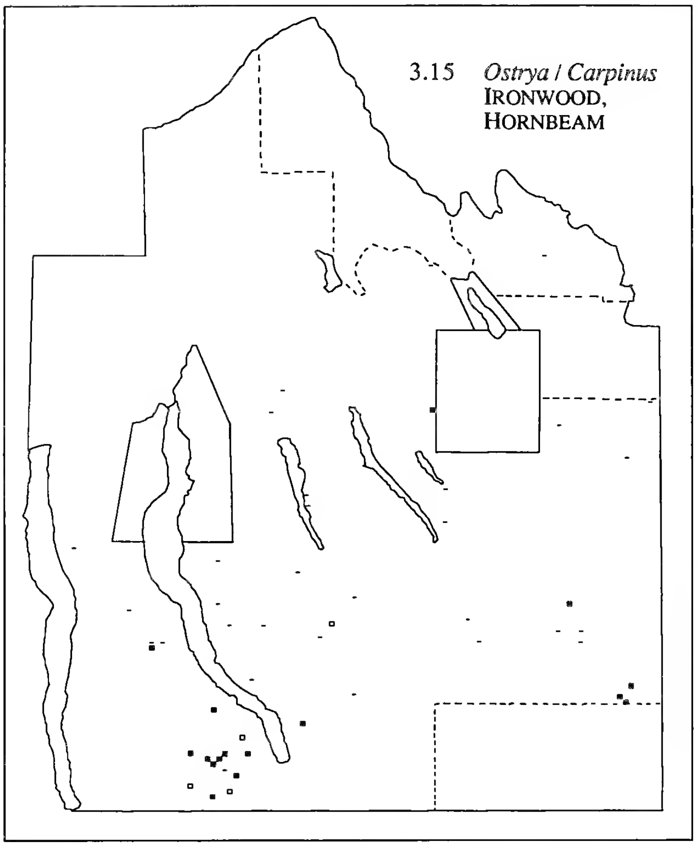

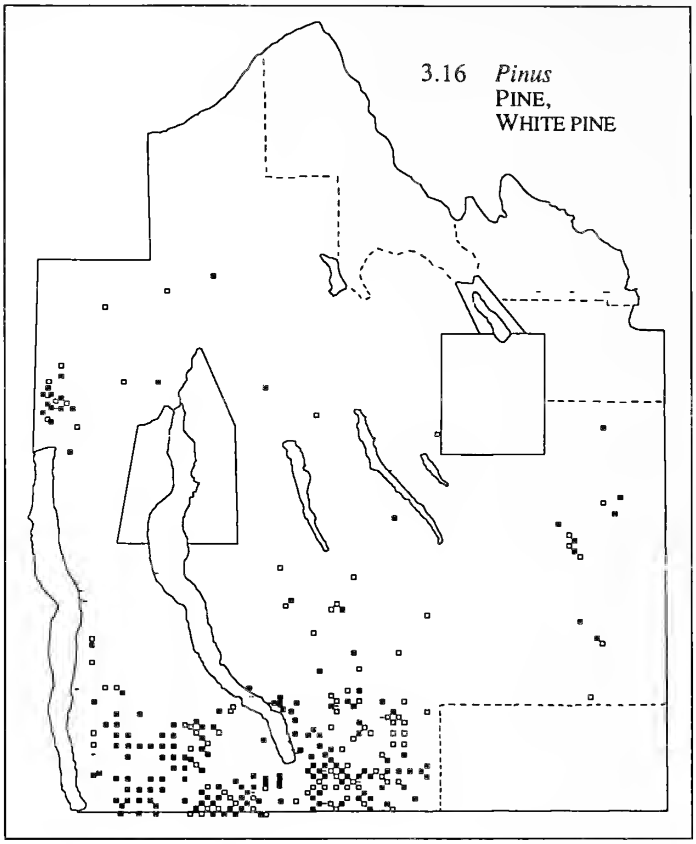

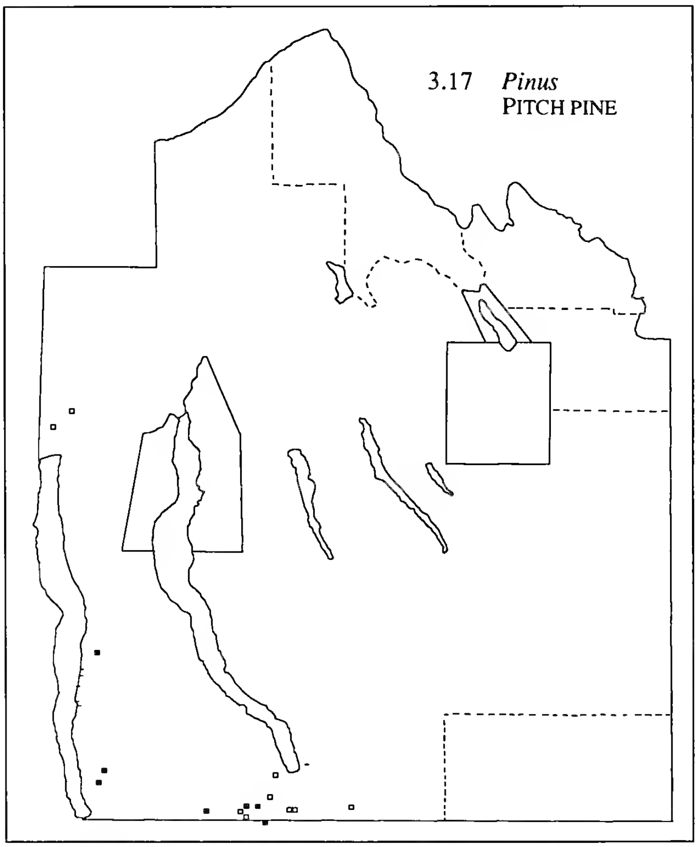

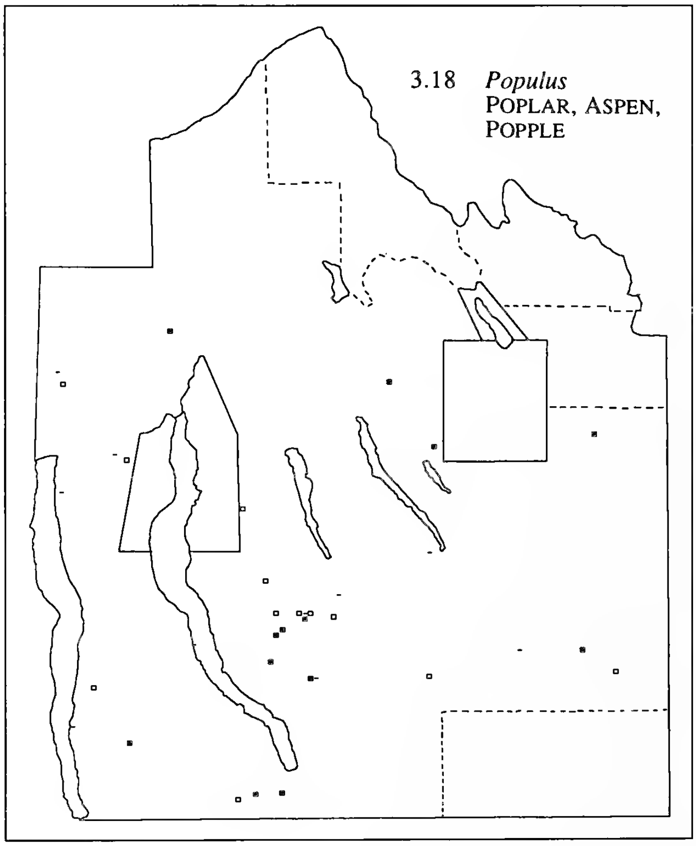

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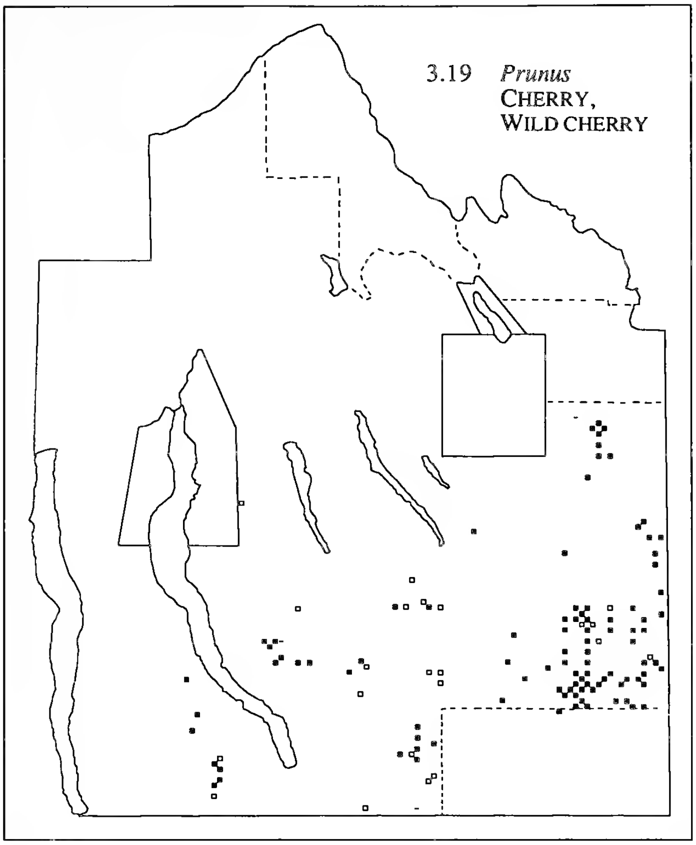

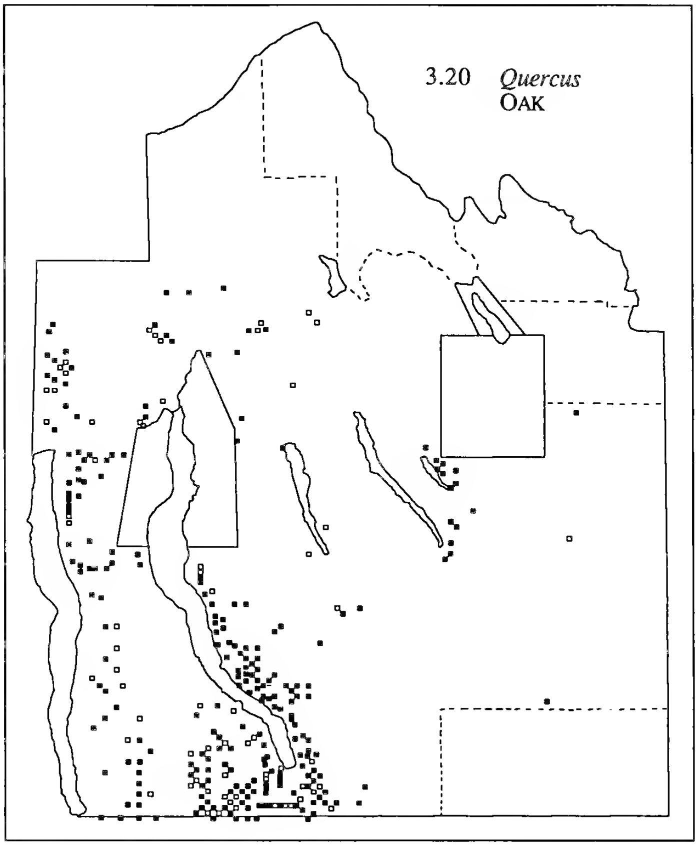

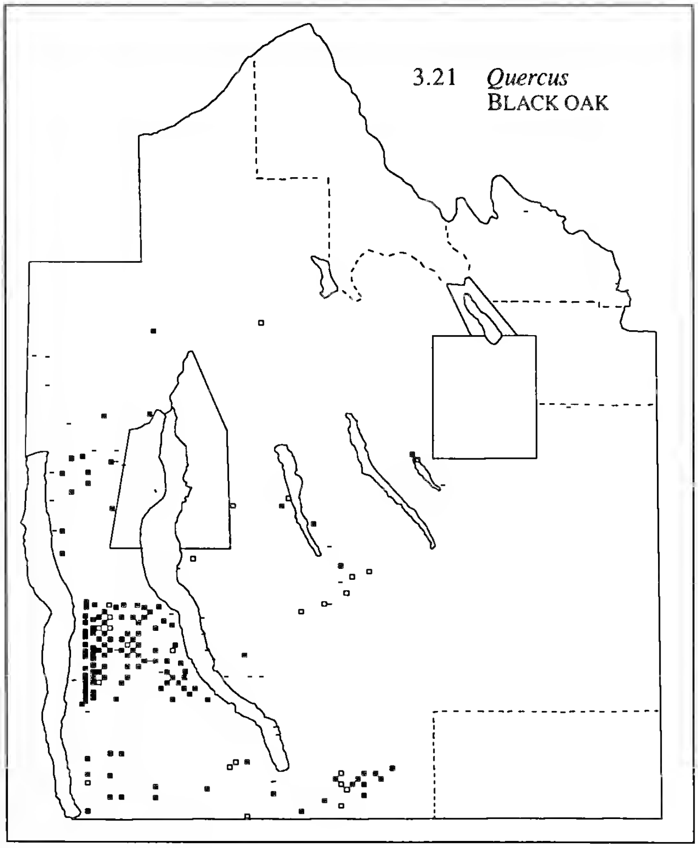

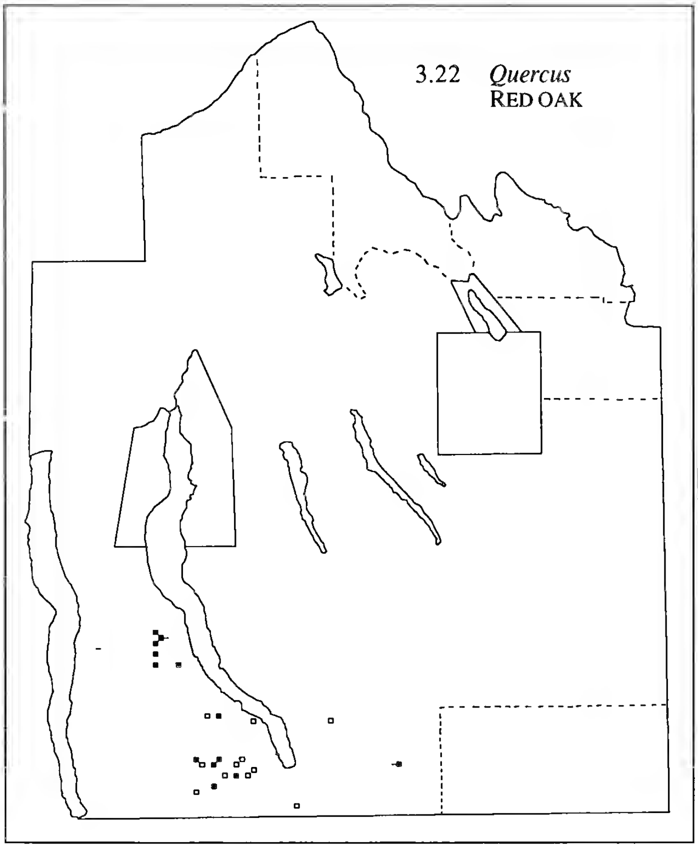

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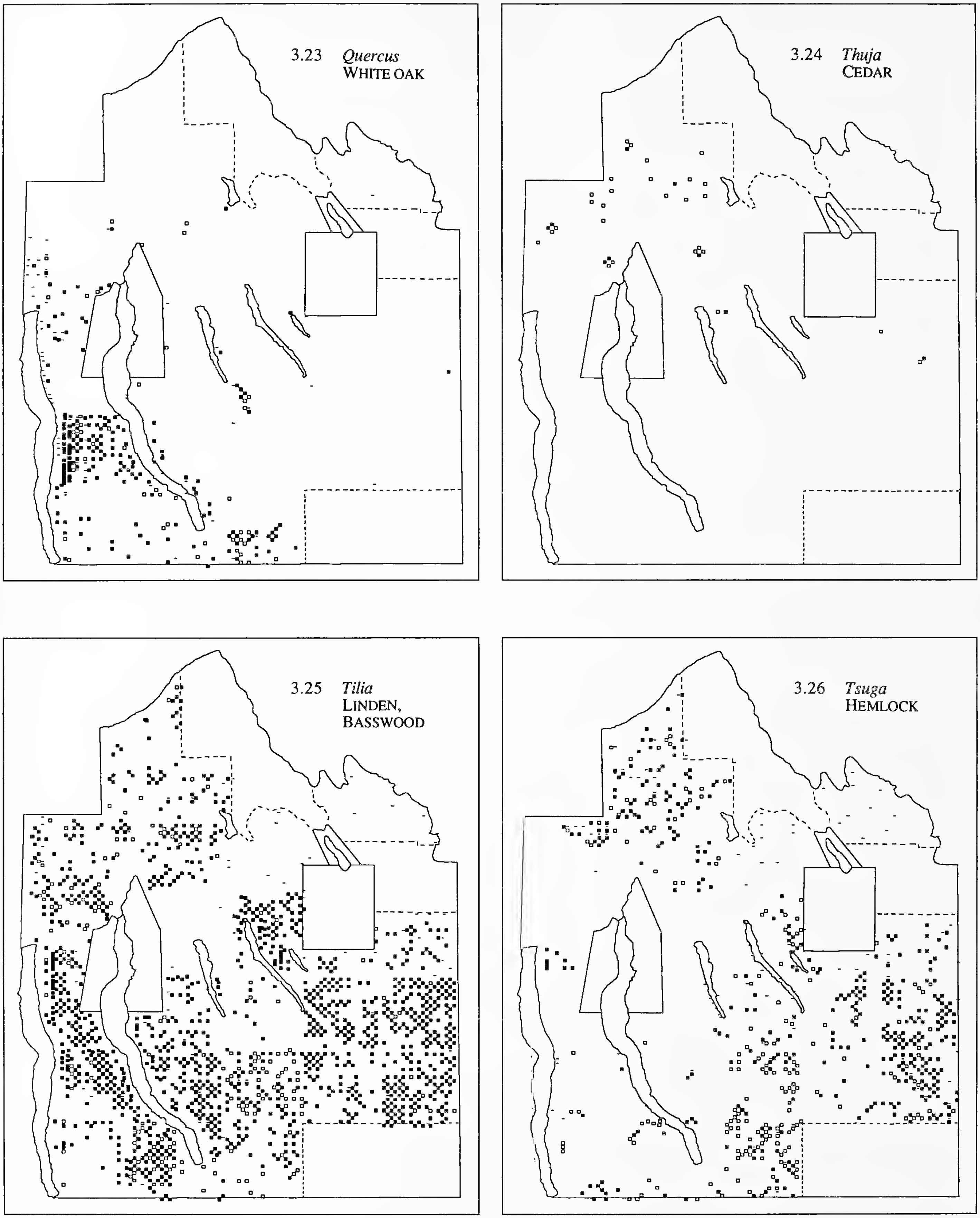

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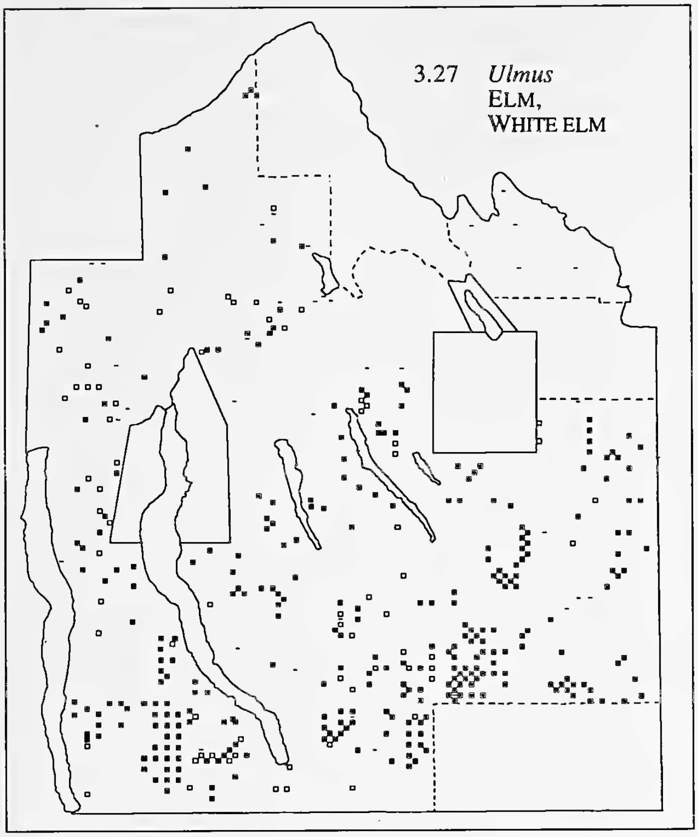


Fig. 3 (concluded).

frequency within the bounds where it co-occurred with these species.

Of the 36 species recorded at witness corners, 23 were represented as "saplings" as well as trees. A total of 15% of the witness data were recorded as "saplings." Since these occurred in all but one of the townships, there appeared to be no surveyor bias in differentiating saplings and trees. The use of saplings as witness trees was not an indication of open areas (i.e., lacking trees) since saplings were used in forested bounds; apparently these understory stems were closer than any canopy tree to the lot corner. The ranks of species as saplings or trees were similar. Of the beech, maple, hard maple, and linden at witness corners, 13% to 17% of each were saplings. Ironwood and hickory were overrepresented as saplings (>35%), and hemlock and white oak were underrepresented as saplings (<8%).

The witness stake data were primarily (92%) from 6 of the 23 townships (#14, 16, 17, 19, 20, and 22). Therefore they may reflect regional vegetation differences and surveyor bias. For instance, although beech was the most common species used for stakes (37%), 17% of the stakes were "hard" or "sugar" maple, compared to 8% for witness trees. This was because 82% of the stake data were recorded by the only two surveyors (Cuddebach and Hart) who consistently used these terms rather than "maple." The third most commonly used species was ironwood, with 10% of the stakes, compared to 1.6% as witness trees and saplings, perhaps because shade-grown *Ostrya* or *Carpinus* saplings were plentiful and the right size for stakes. It is possible that ironwood was infrequently recorded along bounds (<1%) because stems in the understory would not have been included in the boundary descriptions. Hickory, another species commonly recorded as "sapling" at witness corners, was used for 5.6% of the stakes. The two species underrepresented as witness saplings, hemlock and white oak, were uncommon as stakes. This suggests that surveyors cut stakes from species that were common in the understory, rather than selecting species that would make better stakes (e.g., be easier to cut or drive, or last longer). The most rot-resistant species readily available, chestnut, was not dramatically overrepresented in stakes compared to witness trees (1.2% of stakes vs. 0.6% of witness trees), but the sample sizes of both were small (6 stakes, 12 trees).

Regional patterns of species distribution

Maps of the occurrence of each of the common taxa, as witness trees and along lot boundaries, showed four basic patterns of spatial distribution through the Military Tract (Fig. 3). Several species were recorded throughout the region. Some were more common to the north, others to the west and south, and a few were recorded across the south or to the southeast within the Tract.

Three ubiquitous taxa were beech (Fig. 3.8), maple and hard maple (Figs. 3.1, 3.2), and linden (Fig. 3.25). These were the taxa most frequently recorded by surveyors on lot bounds (Table 3). Although not as abundant, hemlock also occurred across the tract, in the northwest and the southeast (Fig. 3.26). Hemlock

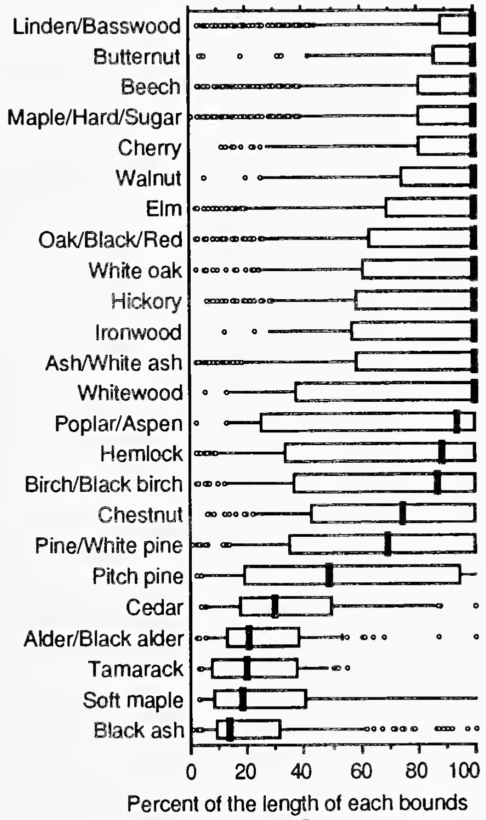


Fig. 4. Boxplots of relative bounds length for the common taxa (those recorded in >15 bounds). Relative bounds length is the distance in which a taxon was recorded as a percent of the length of that bounds. Dark bar is the median, box is 25th to 75th percentiles, horizontal lines are 10th to 25th and 75th to 90th percentiles, and dots are outliers. Bounds lengths were usually 1.5-1.7 km.

Table 4. Frequencies, sizes, and species of the different wetland types recorded by the surveyors. *Swamps* does not include "swampy" or "low" land. *Wet thickets* are "alder swamps" in which no tree species were recorded; "alder marsh" was included in the *Marsh* category. The sites described as "old beaver dams" were 2 swamps, 2 marshes, and 1 meadow.

(a) Wetland sizes, and abundance relative to the total number and distance of surveyed bounds. Maximum distance includes patches extending along >1 lot bounds. The total percent of bounds for *Wet open areas* is less than the sum because 10 bounds had two of the types.

	Percent of total number (4100)	Percent of total distance (6433 km)	Median distance (km)	Maximum distance (km)
Swamps	16.1%	3.7%	0.24	3.1
Wet open areas				
Wet thickets	1.0	0.3	0.32	1.6
Marshes	2.5	1.1	0.40	4.6
Meadows	0.2	0.03	0.15	0.4
Total	3.5%	1.4%		
Old beaver dams	0.1%	0.03%	0.38	0.8

(b) Species recorded in wetlands, relative to the number of bounds in which each category was mentioned. Since no species were named in many of the swamps and most marshes, and since species co-occurred, these do not sum to 100.

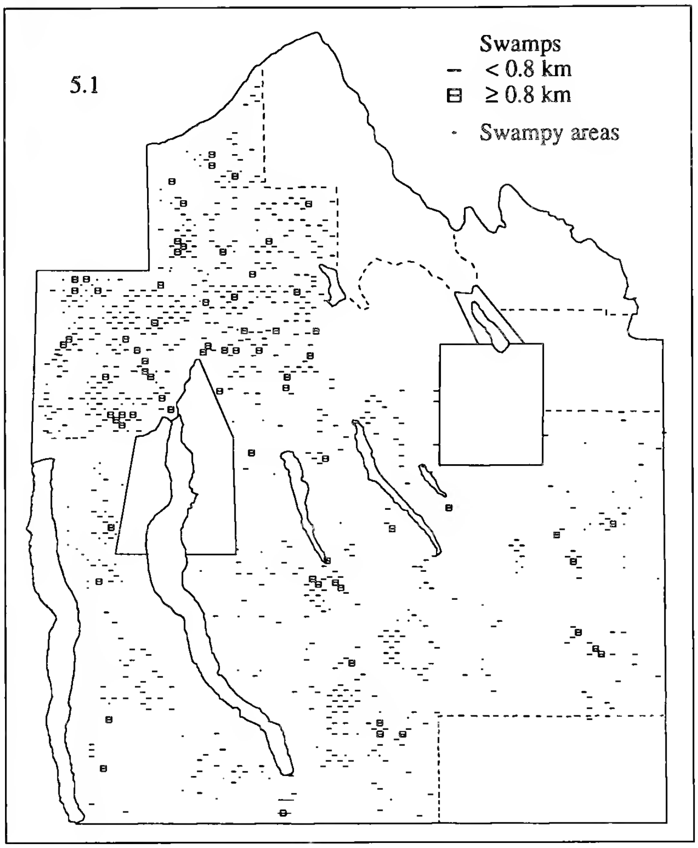
Swamps	% of 660
Black ash	47
Hemlock	9
Tamarack	7
Elm	5
Ash	5
Cedar	5
Pine, white pine	5
Maple	5
Alder, black alder	5
Soft maple	2
Black birch	2
White ash	1
Spruce	1
Birch	1
Basswood	1
Hard maple	1
Beech	0.3
Willow	0.3
Swamp oak	0.3
White maple	0.3
Cranberry	0.2
Buttonwood	0.2
Pepperidge	0.2
Huckle-berry	0.2
Flag	0.2
Brack	0.2

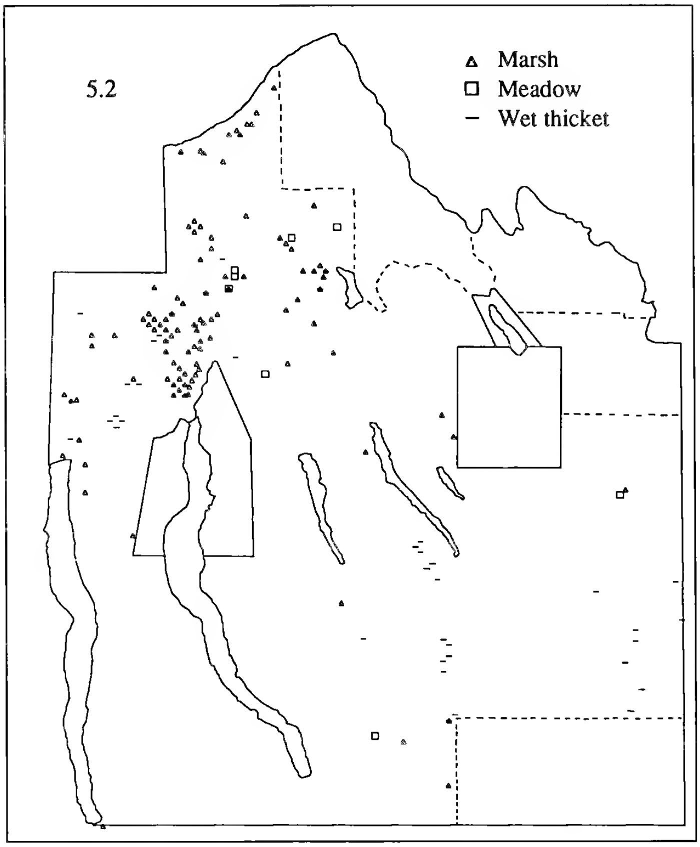
Marshes	% of 102
Alder	7
Cedar	2
Cranberry	2
Grass	2
Tamarack	1
Black alder	1
Black ash	1
Flag	1
Brakes	1

Wet thickets	% of 42
Alder	62
Black alder	38

Meadows	% of 8
Grass	25
Fowl meadow grass	13

Old beaver dams	% of 5
Black ash (swamp)	20





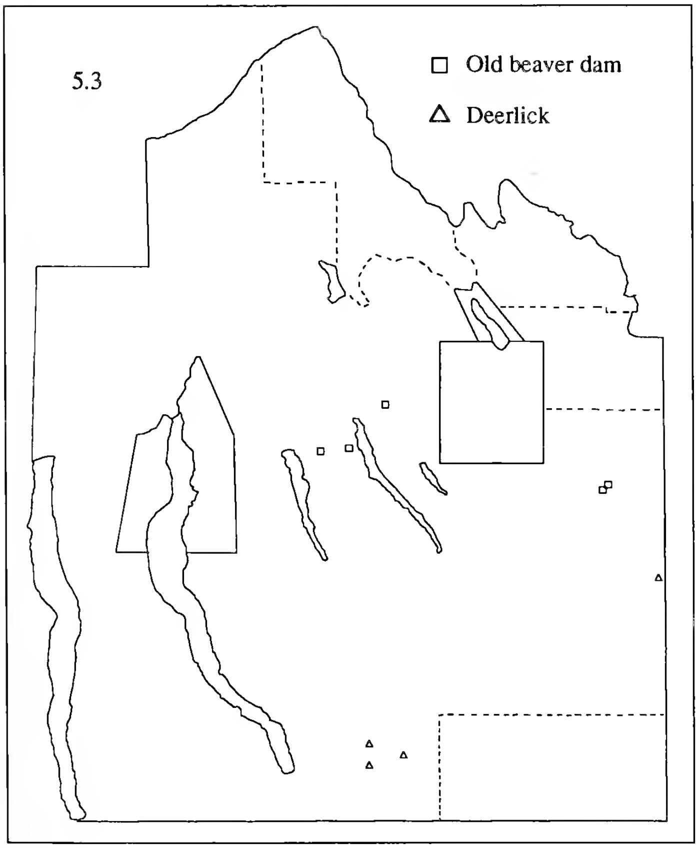


Fig. 5. Wetlands mentioned in the survey records.

5.1) Swamps, showing small ones (<40 chains, <0.8 km) separately from large swamps, and swampy areas (e.g., "low and wet," "inclining to swamp").

5.2) Wet open areas: marshes, meadows, and wet thickets (alder swamps with no mention of trees).

5.3) "Old beaver dams" (2 swamps, 2 marshes, and a meadow), and "deerlicks" (apparently along creeks).

was common both as witness trees and along bounds (Table 3).

Species reported more frequently in the northern part of the study area were cedar (*Thuja*, Fig. 3.24), tamarack (Fig. 3.13), and to a lesser extent black ash (Fig. 3.10) and alder (Fig. 3.4). All of these were wetland species (Table 4), and swamps and marshes were abundant to the north (Fig. 5) in the drumlin region.

The oaks (Figs. 3.20-3.23), walnut (Fig. 3.12), and hickory (Fig. 3.6) occurred primarily in the southwest of the tract, particularly between the two large lakes, Seneca and Cayuga. On the west/southwest-facing banks of the Finger Lakes, two thirds of the witness trees were white or black oak, pine, and hickory (66% of 91), in contrast to the east/northeast-facing banks, where the most common taxa were hemlock, beech, maple, and hard maple (57% of 53). Although red oak appears to have an extremely restricted distribution within the Tract (Fig. 3.22), only three surveyors used the name, while the others presumably called it "black oak" or "oak." The surveyors recorded pine and chestnut primarily along the southern edge of the study area (Figs. 3.16, 3.7). Chestnut also occurred further to the northeast (near the Onondaga Reservation). Pitch pine (Fig. 3.17) was mentioned both in the Junius region north of Seneca Lake and southeast of Cayuga Lake, two sites where pitch pine occurs today (Seischab and Bernard 1991). Pitch pine was also recorded as witness saplings and trees on the bank of Seneca Lake. It was not recorded in any burned areas, but in one bounds in Junius the surveyor crossed beech/maple land into "open land, timber destroyed by fire" and then came "out of the burnt land into pitch pine."

Another group of species included ash, butternut, and elm (Figs. 3.9, 3.11, 3.27); these were predominantly distributed across the southern half of the tract, but also occurred in the north. Cherry (Fig. 3.19) and birch, including black birch, (Fig. 3.5) had distinctly southeastern distributions.

Some woody species occurred predominantly on the Ontario Lowland or on the Allegheny Plateau (see Fig. 1 for the boundary between the two regions). However, the abundances of each of the most common taxa (beech, maple, linden, and hemlock), relative to other species within each region, were quite similar for the Lowland and Plateau (Fig. 6). Relative to other species, black ash was much more abundant on the Lowland than the Allegheny Plateau, either based on the total bounds distance or on the number of witness trees within each region (Fig. 6). The other wetland trees were also more common on the swampy Lowland. Species with notably greater abundances on the Plateau than the Lowland were pine, pitch pine, chestnut, and the oaks (Fig. 6). Ash, butternut, and elm were relatively more abundant on the Plateau than the Lowland based on bounds distance, although the witness data did not reflect this, perhaps due to the small sample sizes for witness trees of these species.

Minor species

Many species were mentioned from 1 to 12 times in the lot boundaries and at witness corners (Table 3, Fig. 7). A number were wetland species. White maple (Fig. 3.3), like soft maple, was recorded both on the Lowland and Plateau, usually in

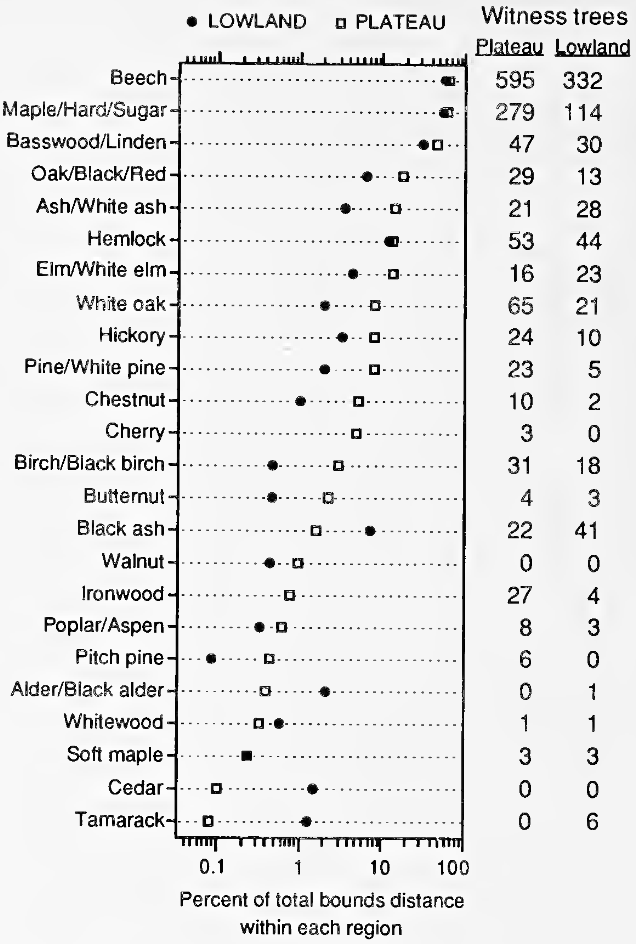


Fig. 6. Comparison between the relative abundances of the common woody taxa on the Allegheny Plateau and on the Ontario Lowland. Percent of total bounds distance for each taxon is relative to all bounds with any woody species recorded: 3323 km on the Plateau, 1192 km on the Lowland. Note that the logarithmic scale exaggerates differences for taxa with low abundance. The sample sizes for witness trees were 1284 on the Plateau (1267 were common taxa, listed here) and 708 on the Lowland (702 listed here).

swamps. Willow was mentioned only in swamps or "swampy" areas, mostly on the Ontario Lowland (Fig. 7.1). "Buttonwood" (*Platanus*) was recorded on the banks of rivers or lakes, and in swampy areas (Fig. 7.1). Spruce, which was listed exclusively in swamps and therefore was *Picea mariana*, occurred both on the Lowland and on the Plateau (Fig. 7.2). These would have been acidic bogs (Wiegand and Eames 1926); tamarack was also present in two of the swamps with spruce.

North of Seneca Lake in the township of Junius, in a region of patches of well-drained sandy soil and "a great many swampy holes," huckle-berry (Fig. 7.2) was recorded with pine and scrub oak and as underbrush in a "maple swamp." The "scrub oak land" and "scrub oak bushes" clustered in this region (Fig. 7.3) could have been *Quercus ilicifolia*. To the south, the two mentions of "scrub oak ridge" along the west facing slope at the lake may, like the nearby "scrubby oak ridge," refer not to *Quercus ilicifolia* but to stunted growth of another species. The five occurrences of "rock" or "chestnut" oak were at the extreme southern and western edges of the Military Tract (Fig. 7.3). The same distribution

was seen for other components of xerophytic oak forest (e.g., pitch pine, chestnut). Swamp white oak and swamp oak (*Q. bicolor*) were confined to the Ontario Lowland (Fig. 7.3), and all five occurrences were in swamps or "low land."

Several species were associated with forest disturbances. "Thorn" (*Crataegus*), "thorns" and "briers" occurred on the Plateau (Fig. 7.4) in former clearings made by Native Americans, and in blowdowns. Currants occurred in one of the same areas of blowdown. "Thorns" also were noted in a burn: "little or no timber, occasioned I suppose by fire, but very thick covered with thorns and hazelbushes." The northern occurrence of hazel (Fig. 7.4) was as underbrush in an oak/hickory woods. Such habitats suggest *Corylus* rather than *Hamamelis* (witch hazel). Plum was recorded in two "old clearings." This was probably *Prunus nigra*, which was cultivated by the Iroquois (Hedrick 1933).

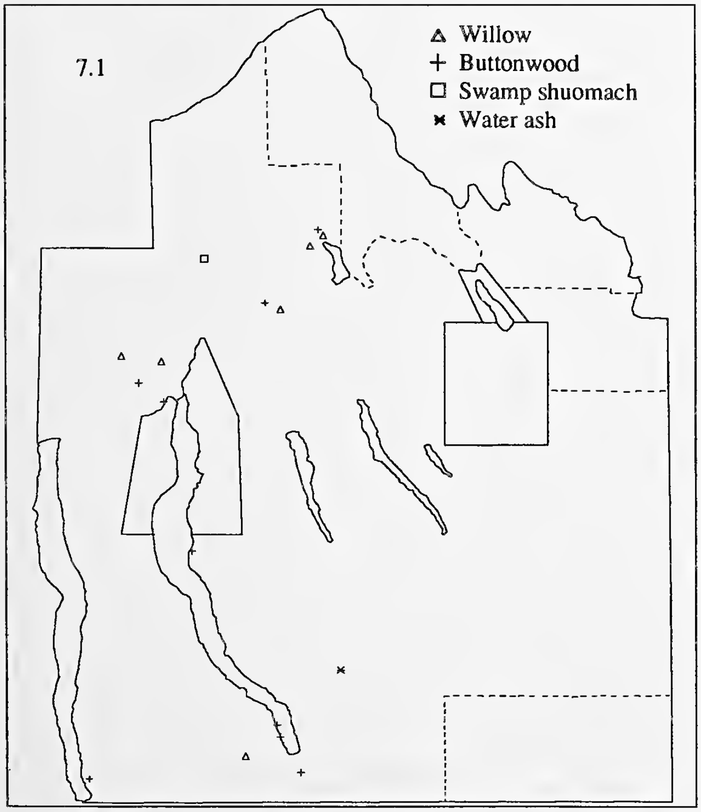
The surveyors recorded little information about herbaceous plants. In the >2700 lot boundaries with species information, herbs were mentioned only 26 times. Fourteen of these were in two townships (Solon and Dryden) where apparently the surveyors were more conscientious or perhaps better acquainted with the species. "Nettles" were associated several times with "good land;" Wyckoff (1988) commented that in the late 1790s in the Holland Land Company tract in western New York, surveyors were instructed that a rich growth of nettles was a sign of fertile land. Other species recorded in the Military Tract were mayapples, rushes, coltsfoot (more likely the native *Caltha palustris* than the European *Tussilago farfara*), maidenhair, oak of Jerusalem (perhaps the European *Chenopodium botrys*), and wintergreen. The "brack about 4 feet high" in a swamp and "large brakes" in a marsh were more likely *Osmunda* than *Pteridium*. Other wetland herbs were flag (probably *Typha*) and fowl meadow grass (*Glyceria striata* or *Poa palustris*).

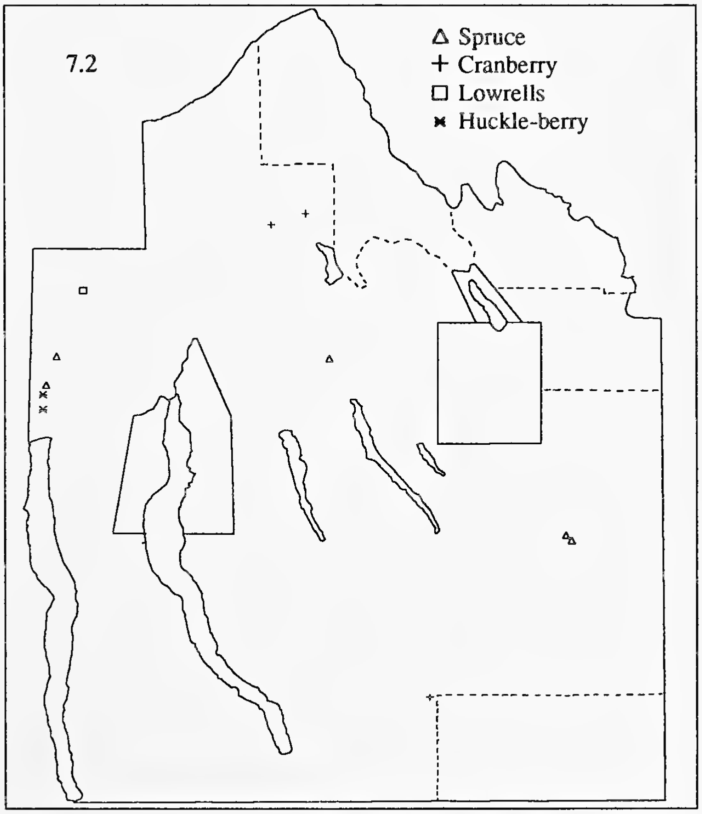
Forest vegetation types

To help understand and summarize the plant communities of the central Finger Lakes region, we used the TWINSPAN computer program (Hill 1979) to classify each bounds into a community type. The TWINSPAN analysis produced eight community types (Fig. 8), each of which either had too few samples to justify subdividing further (e.g., Alder type, n = 20 bounds), or would split into overlapping categories (e.g., Pine-Oak would become Oak-Pine with some chestnut, and Pine-White oak-Chestnut).

These eight types formed three groups: swamps (Cedar/Tamarack, Black ash, and Alder), upland mesophytic forests (Hemlock-Beech, Beech-Maple-Linden, and Maple-Linden-Oak-Ash), and xerophytic woods (Oak-Hickory and Pine-Oak). The names used here for the community types are those taxa found in at least half of the bounds in the category. Since the surveyors usually recorded only 2 to 4 species in each bounds, our names for the eight types are representative of groups of species that were often listed together.

Since TWINSPAN is not based on single indicator species, and since some bounds were heterogeneous, taxa also occurred to a limited extent in other types. Therefore to describe the types more fully it is useful to mention additional species that were frequently recorded. Three swamp types accounted for 6% of the bounds in the analysis (Fig. 8). The Cedar/Tamarack type included swamps with cedar (*Thuja*) or with cedar and tamarack





Figs. 7.1-7.6. Maps of woody taxa mentioned <15 times in the survey records. The same symbol is used for witness corners and lot bounds. Boundary information was mapped at the centers of lot bounds, so locations are approximate.

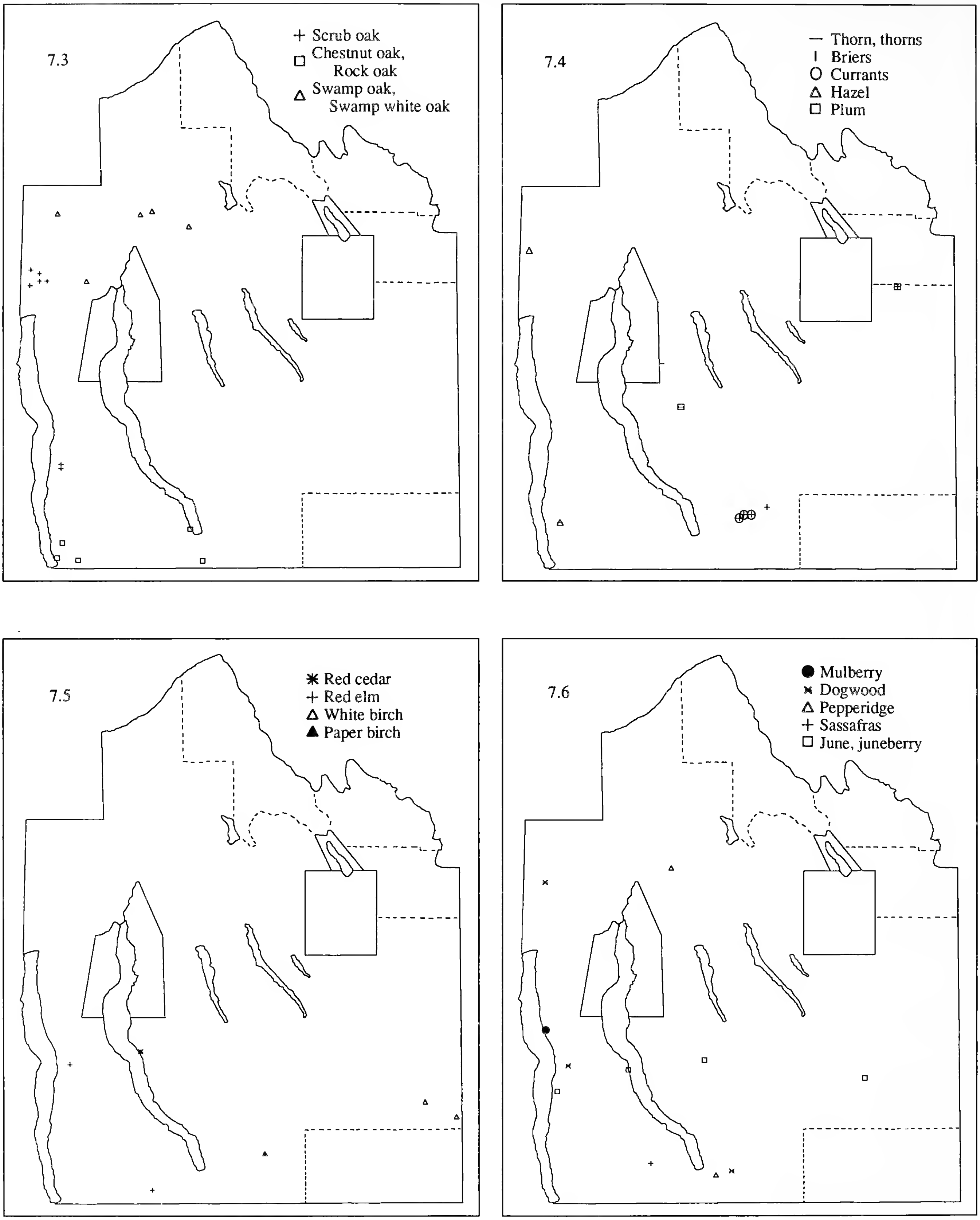


Fig. 7 (concluded).

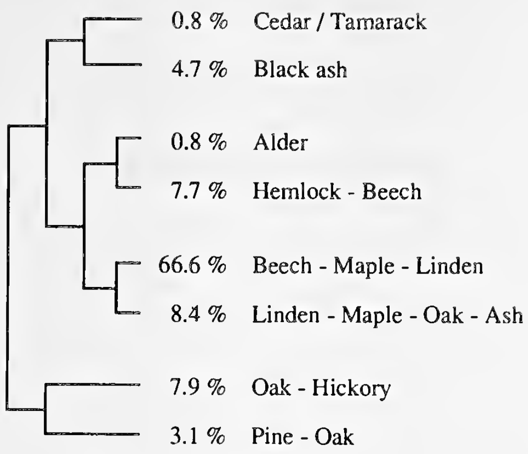


Fig. 8. Relationships among the eight community types. The TWINSPAN analysis was based on relative distance along each bounds of the 23 woody taxa mentioned >15 times. The number of bounds classified into each type is shown as a percent of the total of 2466 bounds included in the analysis. For each vegetation type, names shown are the species that occurred in at least half of the bounds in that group, in order of decreasing frequency. Tamarack was in 47% of the bounds in the first type. Oak includes "oak," "black oak," and "red oak." Alder includes "black alder." Maple includes "maple," "sugar maple," and "hard maple."

(*Larix*), which were presumably calcareous, and swamps with tamarack but not cedar, which could have been either acidic or calcareous (Wiegand and Eames 1926). The Black ash type was primarily "black ash swamp," but sometimes additional species were listed, e.g., hemlock, elm, cedar, or tamarack. Most occurrences of "alder swamp" and "black alder swamp" had no other species; a few listed elm. These same kinds of swamp also occurred on small distances within bounds classified by TWINSPAN as upland types, since we treated bounds as units. As mentioned earlier, swamps usually were short relative to bounds lengths, and although 16% of the surveyed bounds contained swamp, they totalled only 3.7% of the distance (Table 4). Swamps with black ash occurred on 11% of the bounds where surveyors recorded species (309 of 2764), but because of their small size relative to the upland forests within the same bounds, the Black ash type accounted for <5% of the bounds in the community analysis.

The overwhelming majority of bounds (83%) were in upland mesophytic forest (Fig. 8). Beech-Maple-Linden was most abundant, with 67% of the bounds. Often surveyors listed only these three taxa in a bounds, in this order, e.g., "beech, maple, linden, etc.," and "beech, sugar, and linden" (we included "hard" or "sugar" maple with "maple"). Other typical combinations recorded by surveyors in this type were "beech and maple," "maple and basswood," "beech, maple, and elm." Linden was often third or second; if the order reflected abundance, this may explain linden's low frequency as a witness tree, relative to the number of bounds in which it was listed.

The other mesophytic types, Linden-Maple-Oak-Ash and Hemlock-Beech, were less common than Beech-Maple-Linden (Fig. 8). Many bounds in the linden group had only two or three of the four taxa, e.g., "linden, maple, ash, etc.," but some did include all four: "hard maple, linden, white and black oak, white ash, and a few butternut." In some Hemlock-Beech bounds hemlock was listed first, some were "chiefly beech," and not all bounds in the type had both species.

Of the two upland xerophytic types, which accounted for 11% of the bounds, Oak-Hickory was more common than Pine-Oak. These types would also have occurred frequently in Hector (the township omitted from the TWINSPAN analysis because of scanty distance data). The Oak-Hickory type included bounds with "black and white oak, hickory, etc.," "oak, chestnut, and hickory," and the only quantitative record: "timber one-third each linden, oak, and hickory." Examples of the Pine-Oak type were "pine, oak, ete.," "white pine, white oak, chestnut," and "black and white oak, some pitch and white pine."

Geographic relations

The map of these eight vegetation types in the Military Tract shows three general regions: eastern, northwestern, and southwestern (Fig. 9). The eastern portion, including much of the central area, was predominantly Beech-Maple-Linden forest at the time of the survey. It also had much Hemlock-Beech forest, as well as a scattering of Alder thickets and Black ash swamps.

The Lowland to the northwest had much Beech-Maple-Linden forest, but it also had Cedar/Tamarack swamps and Black ash swamps (Fig. 9). Because marshes usually lacked woody plants (which were the basis for the TWINSPAN analysis), they were excluded from this figure. However, marshes also were a significant feature in this part of the study area (Fig. 5.2).

Linden-Maple-Oak-Ash, Oak-Hickory, and Pine-Oak forest types were concentrated in the southern and western parts of the Military Tract (Fig. 9). Here, Beech-Maple forest was less common than in the other two regions, though it was still represented. A narrow band of Pine-Oak, Oak-Hickory, and Linden-Maple-Oak-Ash extended northward along the western edge of the Tract.

Most of the bounds in the Cedar/Tamarack and Black ash types were on the Ontario Lowland (84% and 64%), whereas 50% of the Alder type occurred in each region. Most of the bounds in each of the five upland types (70-86%) were on the Plateau. However, in terms of relative abundance of each type within regions, Beech-Maple-Linden was equally common in both: 68% of the bounds on the Lowland, 66% on the Plateau. Since it was possible that the large Beech-Maple-Linden group might be made up of two groups, one with a species composition typical for the Lowland, and one for the Plateau, we looked at how TWINSPAN subdivided this type. Although one group had more elm, and another more hemlock, half of the Lowland bounds were in each group, supporting the conclusion that the Beech-Maple-Linden type occurred across both regions.

Species affinities

The TWINSPAN species classification produced four main groups (Fig. 10): the xerophytes, swamp species, and two groups of mesophytes. Walnut and poplar (including aspen and whitewood) were closer to the group with hickory, oaks and pines. Birch, presumably a mixture of black and yellow birch, was

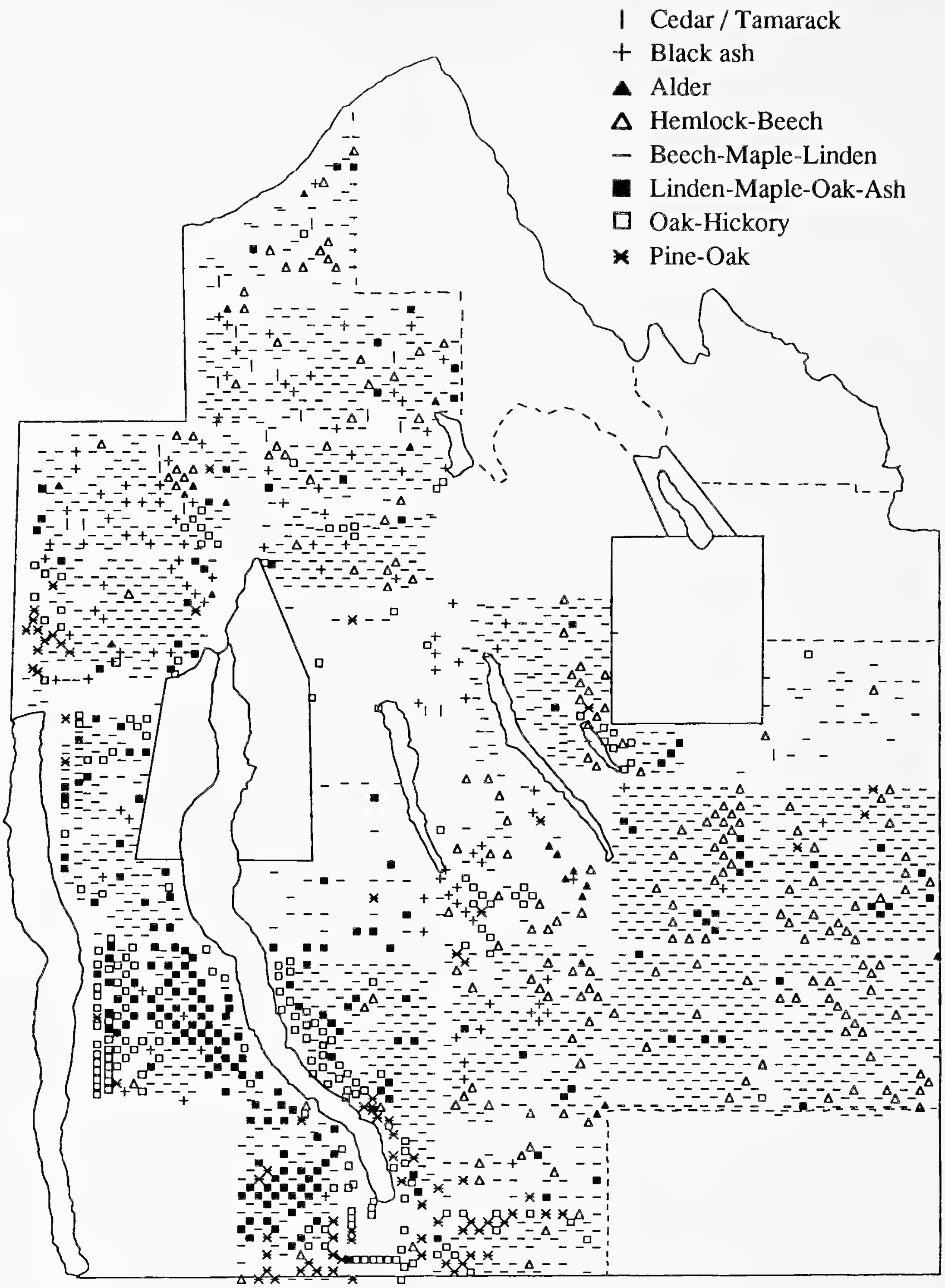


Fig. 9. Distribution of the eight vegetation types across the Military Tract.

included in the swamp group. Yellow birch occurs with hemlock and red maple in certain swamps of the region today (Mohler 1991). There seems to be little basis for distinguishing the two groups of mesophytes, in terms of ecological or environmental correlates. The grouping of ash, ironwood, and linden may reflect an association with nutrient- and base-rich sites, as Crankshaw and colleagues (1965) found in Indiana.

Quality of the land

The surveyors' descriptive terms for the quality of land or soil were often based on the vegetation (Munro 1804). The Linden-Maple-Oak-Ash type was considered best, with 77% of the bounds described as "good" or "very good" (Table 5). Bounds with Beech-Maple-Linden or Oak-Hickory were also considered to be generally good, although a few bounds in these types were

Table 5. Surveyors' terms for the quality of land or soil in each of the community types. The percent of the bounds in each type of vegetation to which these descriptive terms were applied is relative to the total number of bounds in that community type (shown in parentheses). Since not all bounds were described, and more than one term could be used (e.g., "poor, cold land"), the percents in each column do not sum to 100.

	Cedar Tamarack (19)	Black ash (115)	Alder (20)	Hemlock Beech (191)	Beech Maple Linden (1642)	Linden Maple Oak, Ash (207)	Oak Hickory (195)	Pine Oak (77)
Very good, excellent, rich, exceeding good	•	•	•	0.5%	5%	11%	5%	•
Good, fine, pretty good, middling rich	•	2%	•	6%	57%	66%	41%	14%
Middling, middling good, tolerable, tolerable good, indifferently good	•	2%	•	13%	16%	8%	19%	14%
Poor, indifferent, not very good, very poor, bad	5%	7%	•	32%	5%	•	14%	44%
Cold	•	•	•	2%	0.5%	•	•	1%
Swamp, swampy, marsh, wet, mirey, inclining to swamp	100%	100%	100%	15%	3%	8%	•	8%
Level, flat, bottom	•	•	•	4%	6%	5%	2%	3%
Rough, uneven, broken, ridge, ridgy, hilly, mountainous, hills and dales, rises and falls	•	•	10%	33%	11%	1%	5%	17%
Stony, rocky	•	•	•	2%	3%	0.5%	7%	6%

called "poor land." In contrast, Pine-Oak and Hemlock-Beech bounds were often "poor" or "indifferent." A few of the bounds with hemlock, beech, or pine had "cold" soils.

All of the bounds in the Cedar/Tamarack, Black ash, and Alder types were "swamp" (Table 5). A few of the Hemlock-Beech type were swamps, and there were also occasional swamps with maple or pine. Terms for flat, level land were occasionally used, in each of the non-swamp types. The vegetation on ridges or rough, hilly, or uneven land was often Hemlock-Beech or Pine-Oak (Table 5). The "rough" bounds in the Alder type were apparently difficult to cross rather than being hilly: "very rough and mirey along the creek," and "a very rough black alder swamp." A few bounds were noted as stony or rocky, especially in Oak-Hickory and Pine-Oak areas.

Openings in the forest

In the 1790s when the Military Tract was surveyed, the central Finger Lakes region was predominantly forested. But scattered across the landscape were patches available for species of open habitats. Some were due to natural disturbances such as wind and fire. Others were more permanent openings due to the soil being too dry and infertile to support closed forest, although many of these areas were probably also affected by fire. People, in clearing fields and setting fires, also created open areas. Beaver dams produced marsh and meadow habitat, while other marshes and meadows would have been due to topography and drainage.

Wind

Blowdowns encountered by surveyors along lot boundaries sometimes were simply noted as "entered a windfall." Others were described in more detail: "large pine trees blown up by the roots," and "blown down by a hurricane, perhaps, some ages ago, which makes it very difficult passing." All of the windfalls in the survey records were on the Allegheny Plateau, to the south within the Military Tract (Fig. 11.1). In many of the windfalls they noted thickets of saplings, including beech, birch, or cherry, and bushes such as "thorns and briers." We therefore suspected that nearby "thickets" with similar species (Table 6) were also in blowdowns. All of the windfalls and nearby thickets were in mesophytic forest, some near swamps, others on hilly uplands.

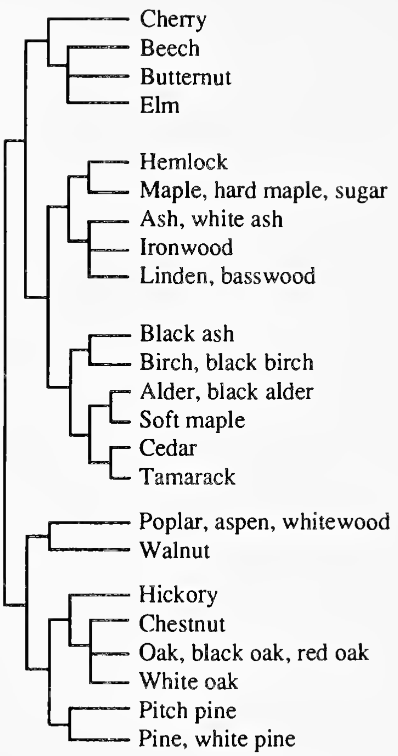


Fig. 10. A dendrogram of the relationships among 23 woody taxa, which was produced by the TWINSPAN analysis.

None of the brushy patches assumed to be blowdowns were on level land near areas recorded as "old clearings" made by Native Americans.

The median distance along bounds for windfalls and associated thickets was <0.5 km (Table 7). If blowdowns were essentially circular in shape, this distance implies a median size of 14 ha. The smallest windfall recorded was 0.2 km along a bounds, with an area of 3 ha if circular, and the smallest brushy area likely to have been a windfall ("rough land, covered very thick with young beech, birch, and maple") was 0.1 km, or 1 ha. A large blowdown at the intersection of four lots in Solon was 0.3 by 0.9 km; >20 ha. The most impressive was just north of Fall Creek in Dryden, where three areas recorded as windfall, and also a "great thicket" and a "hemlock thicket," formed a linear track that intersected the bounds of five adjacent lots. This storm track was >6 km long and 0.2 to 0.4 km across (180 ha), suggesting the path of a large tornado or thunderstorm downbursts.

Windfalls and thickets were encountered on 21 bounds, or 0.5% of the total surveyed distance (Table 7), in 9 separate patches. The sum of the lengths of windfalls and nearby thickets recorded along bounds was quite small: 0.17% of the total surveyed distance.

Fire

The surveyors noted 8 burned patches, on 10 bounds, including "timber destroyed by fire," and "has been burned over with fire which has killed all the underbrush." A few were noted as being brushy, e.g., "the timber I suppose has been destroyed by fire and is now covered very thick with underbrush." As mentioned earlier, thorns and hazel occurred in a burned area (Table 6). All of the recorded burns were on the west side of the Military Tract (Fig. 11.2), in the region dominated by oak, hickory, or pine. Several were near "scrub oak land" north of Seneca Lake in Junius, and a few were adjacent to beech-maple forest. Some fires were probably from lightning strikes, such as the chestnut ridge with "timber formerly killed with fire." Others were apparently set by people, as implied by "woods formerly burnt by firing the woods." One burn (Fig. 11.2, near the western edge of the Cayuga Reservation; see Fig. 1) was within a kilometer of a path (see Fig. 11.3). (This path led to the Iroquois village of "Canogy," shown on DeWitt's 1792 map as Connoga, west of Cayuga Lake.)

Burned areas were often larger than windfall patches, with a median distance along bounds of 0.76 km (Table 7). If these were circular, the median area of burns would be 46 ha. The longest distance recorded along bounds was 1.21 km, less than the typical size of a lot, so an unknown number of small burned areas would not have been encountered. The total distance recorded in burns was only 0.10%. However, it is possible that in addition some "open oak woods" and "open oak plains" were the result of fires, and since thick underbrush was noted in three of the burns, other brushy or "scrubby" areas in the oak/pine region may also have been fire-related.

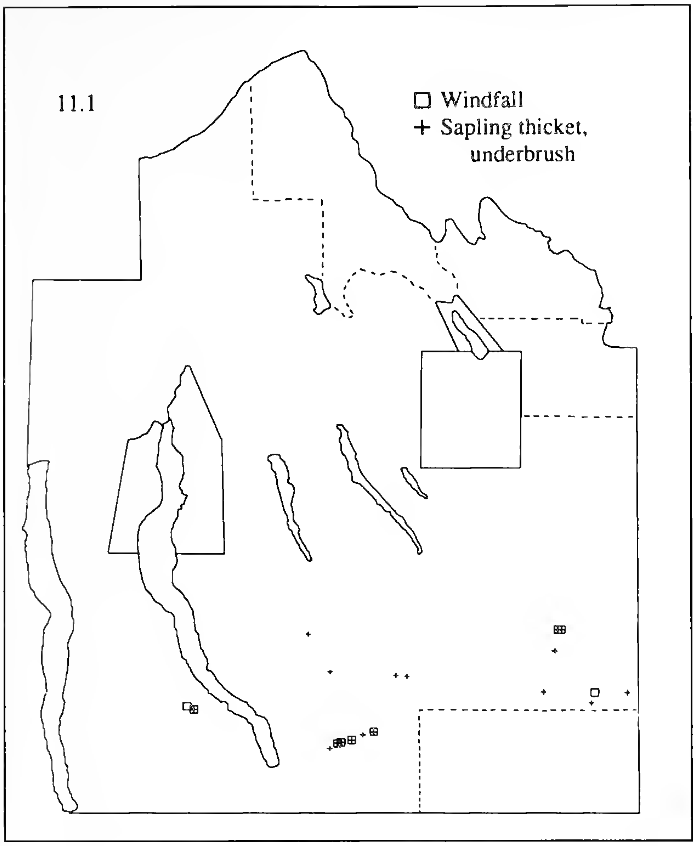
Dry open areas

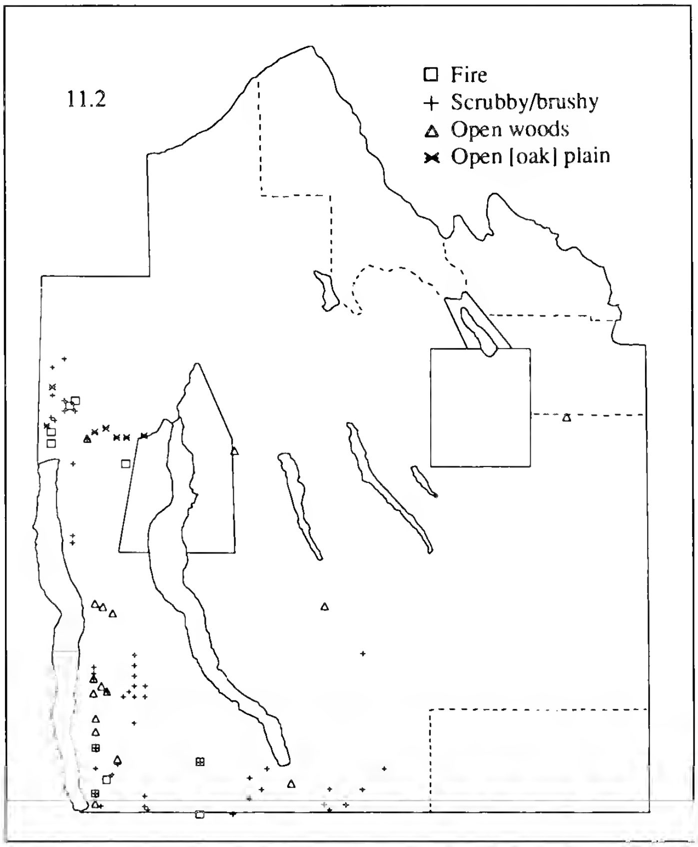
Along the western and southern sides of the Military Tract, areas of stunted growth and sparse tree canopy were common (Fig. 11.2). Patches of "scrubby timber," "thick underbrush," or "scrubby bushes," were recorded north of Seneca Lake in the sandy region in Junius, on the slopes and uplands east of Seneca Lake near a road (Fig. 11.3), and in the hills south of Cayuga Lake. Oaks and pines were common in these scrubby/brushy areas (Table 6). A large area with "scrubby beech," "black and white oak," and "thick underbrush" ran along the top of the upland between the two large lakes (Fig. 11.2).

Other areas of xerophytic or fire-related vegetation included "open oak woods," an "open barren ridge," and "but lightly timbered." White oak and "black oak" were the most common species in this type (Table 6). Most of the occurrences of open woods were on the upland and west-facing slopes along Seneca Lake (Fig. 11.2), often within a few kilometers of the Iroquois road that ran the length of the lake (Fig. 11.3). Both of the "open oak woods" just east of each of the Reservations were next to roads.

A region of "open oak plain," "beech land, open plain," and "clear oak plain" was just north of the Seneca River, between the northern ends of Seneca and Cayuga Lakes (Fig. 11.2). A road ran through this region (Fig. 11.3). This area of open land appeared to extend across at least five lots, and could have been as large as several hundred hectares.

Some scrubby or open areas were large, but like areas recorded as burns, most were <1 km along bounds (Table 7). If generally circular in shape, the median areas would be about 50 ha for open woods or scrub. Scrubby or brushy areas, open woods, and





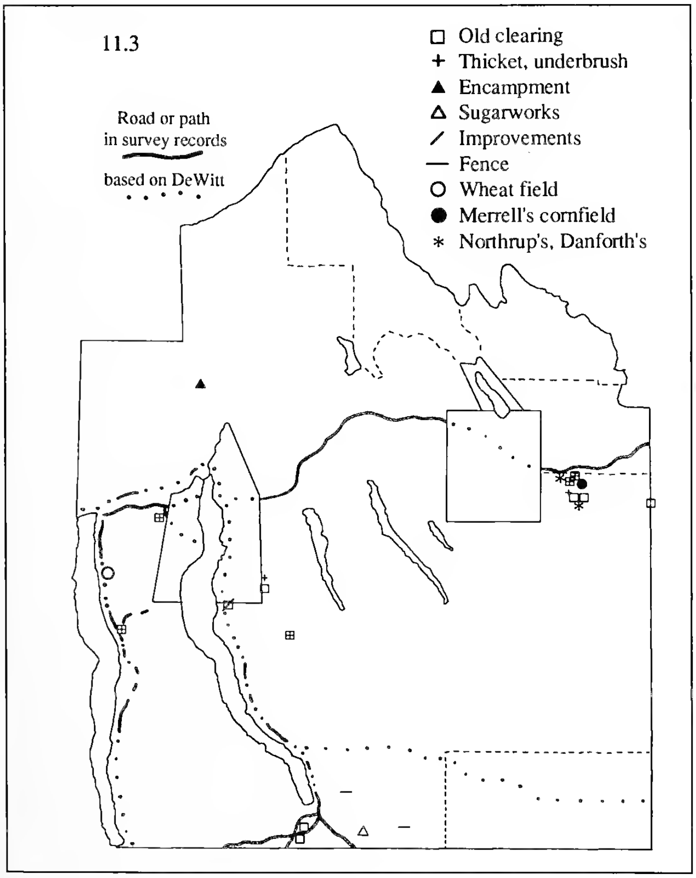


Fig. 11. Maps of disturbances and other open areas recorded by the surveyors. Locations are approximate, shown at the centers of lot bounds, except for windfalls (shown at the midpoint of their distance along the bounds, to indicate the blowdown track).

11.1) Windfalls, and nearby brushy areas likely to be windfalls. The windfalls in which the surveyors reported brush or sapling thickets are shown with both symbols.

11.2) Burned areas, "scrubby" or brushy areas in oak/pine/hickory, open woods, and open plains (usually with oak). The burns in which brush was reported are shown with both symbols (square and plus).

11.3) Areas of human activity recorded by the surveyors. These were: old clearings, two nearby brushy areas, an "Indian encampment," an "Indian sugarworks," "improvements," two mentions of "fenee," a wheat field, Merrell's cornfield and meadow, and other settlers (Northrup and Danforth). Old clearings with brushy thickets are shown with both symbols (square and plus). The "improvements, lately and ancient" is shown as a slash in a square. All roads and paths recorded in the surveyors' maps and boundary descriptions are shown. Dotted portions are based on maps by Simeon DeWitt (1st sheet of his 1792 map of New York, and Map 103C in Cook 1887).

Table 6. Species recorded in disturbances and other open areas. These include saplings, bushes, trees, and burnt or uprooted trees. See text for explanation of categories. The number of bounds in which species were named and the total number of bounds are shown in parentheses, since sometimes no species were listed (e.g., "underbrush," "thicket of saplings," "scrubby timber"). Scrubby/brushy areas and open woods specifically referred to as due to fire are included in *Burned areas*, not the former categories.

SURVEYORS' CATEGORIES	Number of bounds (# with species, of total)	ASSOCIATED BRUSHY AREAS	Number of bounds (# with species, of total)
Windfalls	(9 of 11)	Nearby sapling thickets	(8 of 10)
Beech	7	Beech	6
Birch	6	Maple	5
Hemlock	5	Cherry, wild cherry	3
Cherry	4	Hemlock	2
Thorns	4	Elm	2
Briers	4	Linden	2
Currants	3	Birch	2
Maple	3	Poplar, popple	2
Pine, white pine	3	Black birch	1
White ash	2	White birch	1
Linden	1		
Burned areas	(3 of 10)	Scrubby/brushy areas	(32 of 45)
Thorns	1	Beech	11
Hazelbushes	1	White oak	9
Chestnut	1	Black oak	7
Oak	1	Scrub oak	7
		Pine, white pine	7
Open woods	(13 of 16)	Oak	6
White oak	7	Hickory	3
Black oak	6	Chestnut	2
Oak	5	Maple, hard maple	2
Chestnut	1	Soft maple	1
Beech	1	Hemlock	1
		Birch	1
Open plains	(7 of 7)	Pitch pine	1
Oak	4	Hazel	1
White oak	1	Huckle-berry	1
Beech	1		
Pine	1		
Old clearings	(3 of 12)	Adjacent brushy areas	(1 of 2)
Thorn, thorns	2	Thorn trees	1
Plum	2		
Briers	1		
Aspen	1		

Table 7. Disturbances and other open areas recorded by surveyors. Frequency is relative to the total number and distance of surveyed bounds. See text for explanation of the categories. The totals for percent of bounds number can be less than the sum of the types, since more than one kind could be encountered within a bounds. In calculating median and maximum distances along bounds we used the total lengths of any patches that extended along >1 bounds. The *Dry open* category does not include brush or open woods that surveyors referred to as due to fire. Distances for most *Other human activity* were not recorded. See Table 4 for sizes and numbers of bounds with *Beaver* or *Wet open* areas.

	Percent of total number (4100)	Percent of total distance (6433 km)	Median distance (km)	Maximum distance (km)
WINDFALLS	0.27	0.07	0.42	0.95
Nearby sapling thickets	0.24	0.10	0.32	1.55
Total	0.51	0.17	0.42	
BURNED AREAS	0.24	0.10	0.76	1.21
DRY OPEN AREAS				
Scrubby/brushy areas	1.10	0.67	0.84	6.40
Open woods	0.39	0.23	0.77	2.41
Open [oak] plains	0.17	0.06	0.46	1.55
Total	1.59	0.96		
FIRE + DRY OPEN AREAS	1.83	1.06		
PEOPLE				
Old clearings	0.29	0.17	0.67	2.27
Adjacent brushy areas	0.05	0.04	1.38	1.73
Subtotal	0.34	0.21	0.73	
Other human activity	0.24	[0.01-0.03]		
Total	0.54	>0.2		
DISTURBANCE:				
Wind + Fire + Beaver	0.88	0.30		
+ Human activity	1.39	>0.5		
OPEN AREAS:				
Disturbed, Dry open, Wet open	6.32	2.8		

open plains were mentioned in 1.59% of the bounds, for a total of almost 1% of the total surveyed distance. Although soils and topography would have been responsible for many of these, fire is also likely to have been involved. Combining burns and the other open areas recorded, still only 1.06% of the surveyed distance was affected.

People

By the 1790s, many of the Iroquois villages and fields in this region had been destroyed or abandoned (Peirce and Hurd 1879). The surveyors described all of the "Indian clearings" as "old" or "ancient." Since thickets of "underbrush," thorns and briers, or small trees grew in several of the old clearings (Table 6), we assumed that the two brushy areas on adjacent lots — "level land, covered with thorn trees," and "land very good, thick with small brush" — were also former clearings. A cluster of old clearings in the eastern part of the tract was near an Iroquois road (Fig. 11.3). Other clearings farther west included a "fine large flat" that was "formerly cleared by the Indians" just south of what is now Ithaca.

The lot just east of Seneca Lake that had "once been cleared by the Indians but has since grown up very thick underbrush" was shown on DeWitt's 1792 map as the location of Apple Town. In the survey records a "road from Appletown to Canogy" ran northeast out of that lot, toward an Iroquois village on Cayuga Lake. "Appletown" was an Iroquois village called Kendaia, which had been destroyed in 1779 by General Sullivan's army in his military expedition through this region (Norton 1879).

Only two apparently active Native American sites were encountered on the surveyed bounds. One was a "fine Indian encampment" in Galen (Fig. 11.3). The other was "Indian sugar-works" at the southern end of the tract, in Dryden.

In 1790-91 there were only a few settlers, at least in the region for which we had survey records. All apparently moved into areas of old clearings (Fig. 11.3). At the eastern end of the tract, William Merrell had a house, a cornfield, and a meadow. Just west of "Merrell's Improvement" was a "brook at Northrup's," and southeast of these, "Ensign Danforth's house." On the slope east of Cayuga Lake, the more recent of the "improvements, late-

ly and ancient" was probably made by Roswell Franklin, who moved to this location (near what is now the town of Aurora) in 1783 (Hotchkin 1848). The settlement begun in 1789 by Hinepaw, Yaple, and others in what is now Ithaca (Peirce and Hurd 1879) was in "Martinus Zielie's location of 1400 acres," an area not part of the survey. "Himepough's Mill Creek" (Cascadilla Creek) was mentioned by the surveyors in Ulysses and Dryden. It was not clear whether a wheat field by Seneca Lake, and two fences southeast of Cayuga Lake (Fig. 11.3), were made by European settlers or Native Americans, since by the late 1700s the Iroquois had adopted aspects of European farming practice (W. Wykoff, pers. comm.).

Old clearings and other human activity (not ineluding the creek) were recorded 24 times, on 22 bounds, or 0.54% of the total number. Accurate distances along bounds were not given for the camp, sugarworks, homes, fences, and two of the fields, and some bounds with cleared areas were simply described as "some old Indian clearing," or "chiefly old clearing." The median size of old clearings and nearby thickets was ±0.7 km, or >40 ha, if circular in shape. A total of approximately 0.2% of the total bounds distance was in fields and old clearings.

Wet open areas

Another type of disturbance occurred along streams; five of the bounds with meadow, marsh, or swamp were described as "old beaver dams" (Fig. 5.3, Table 4). The only one of these in which species were recorded was a "swamp, black ash — or rather an old beaver dam." There were no mentions of active beaver sites.

While beaver may have been a factor in creating other wet open areas, many marshes would have been more permanent openings created by drainage patterns. Surveyors often distinguished marshes from swamps, e.g., "out of a cedar swamp into a marsh," and mentioned tree species in only 5% of marshes, compared to >50% of swamps (Table 4). Marshes were common on the Ontario Lowland (Fig. 5.2). The largest marshes were several kilometers across, in the area now known as Montezuma Marsh. The median distance in marsh along bounds was only 0.4 km (Table 4), so they covered only 1.1% of the total boundary distance.

While many of the swamps were forested, there were patches called "alder swamp" or "black alder swamp" in which no trees were mentioned (Table 4). These wet shrub thickets were scattered across the eastern end of the Plateau, and also on the Lowland (Fig. 5.2). They may have been former beaver sites.

Beavers were also responsible for at least one of the areas of open meadow. Eight small natural meadows were mentioned in the survey records (Fig. 5.2, Table 4), including "a marsh meadow," "a clearing, apparently old beaver dams but dry," "a fine shot of clear meadow with beautiful grass," "clear meadow covered with fowl meadow grass," and "a clear fowl meadow." All were at brooks or adjacent to marshes, rather than being old clearings or fire-related.

The marshes, wet thickets, and meadows together were recorded on 3.5% of the bounds, for a total distance of 1.4% of the surveyed distance (Table 4). Although the distances recorded along bounds were generally short (medians <0.5 km), suggesting a median size of about 10 ha, this underestimates the true extent of wetlands, since from the topographic maps it was clear that marshes and swamps along stream courses or in the region of narrow north-south drumlins on the Lowland would have intersected bounds on several lots.

Estimates of total disturbed and open area

We cannot be sure that the surveyors recorded every opening encountered. However, the number of times that they clearly stated when they entered and left swamps, marshes, open woods, and thickets, noted when they crossed brooks, ridges, and roads, and commented on the slope or quality of the land even if they did not list the tree species, makes it likely that most areas large enough to intersect bounds, and sufficiently open to be noticeable, would have been recorded. It was not possible to completely separate "natural" from human impact, or "disturbance" from the more constant effects of the environment. Thus, totals reported here should be taken as approximations.

Very little of the 1790s' landscape was in patches of disturbance due to wind, fire, or beavers: only 0.3% of the surveyed distance, <1% of the number of bounds (Table 7). Old clearings were the most common of the types of human impact recorded, bringing the total area disturbed to 0.5% of the distance. Openings in wetland and dry upland areas were quite common, so altogether 6% of the number of bounds, and 2.8% of the total distance, was in open habitat in the 1790's (Table 7).

Discussion

Just prior to the period of rapid settlement and widespread clearing for agriculture in the 1800s, the landscape of the Military Tract was heavily forested. Over 97% of the surveyed distance was in upland forest or wooded swamps. Within the tract, the central and eastern parts of the Allegheny Plateau were predominantly Beech-Maple-Linden and Hemlock-Beech forests. Oak-Hickory, Pine-Oak, and Linden-Maple-Oak-Ash forests dominated the southern and western parts of the Plateau, ranging north onto the Ontario Lowland at the western edge of the study area. The bulk of the Ontario Lowland was covered with a mixture of Beech-Maple-Linden and Hemloek-Beech forests, and swamp forests of black ash, cedar, or tamarack. Marshes were also common on the Ontario Lowland. The other kinds of forest openings, including windfalls, burned areas, and open oak woods, were predominantly on the Allegheny Plateau.

Species distributions within the region

Several classic vegetation maps show a difference in natural vegetation between the Allegheny Plateau and Ontario Lowland in central New York. Braun (1950), who based her vegetation regions on climate, topography and soils, included the Allegheny Plateau in the Hemlock-White pine-Northern hardwoods Region. On the Lowland, she mapped her Beech-Maple Region. Küchler's (1964) more detailed map of "potential natural vegetation" was similar for central New York except that he showed Oak for-

est as well as Northern hardwoods to the south. Across the portion of the Ontario Lowland for which we had survey records, Küchler's map, like Braun's, showed Beech-Maple forest.

In many ways the distinction between a Beech-Maple Region on the Lowland and Northern hardwoods on the Allegheny Plateau is subtle. Braun's Northern hardwoods and Beech-Maple Regions have many species in common; perhaps the most relevant difference is that her Northern hardwoods Region has more hemlock, white pine, and yellow birch. In the Military Tract, our Beech-Maple-Linden type accounted for two-thirds of the bounds on both the Lowland and the Plateau. At the same time, our results are consistent with Braun since our Hemlock-Beech type was common on the Plateau, as were birch and white pine. In addition, the Lowland differed from the Plateau in having many more swamp forests, especially of black ash.

For New York State in the region to the west of the Military Tract, the survey records from the Phelps & Gorham and Holland Land Company lands showed the basic pattern given by Braun: Beech/Maple forest on the lowland Till Plain, and Hemlock/White pine/Northern Hardwoods on the Plateau (Seischab 1990, and present volume). The Military Tract differed in having only modest differences in the prevalent vegetation type on the two physiographic provinces, as noted above. Such a result may be because the Ontario Lowland within the Military Tract is quite hilly (the drumlin region), whereas the Lowland (Till Plain) to the west in Seischab's study areas is much flatter (Thompson 1966). The forest types from our TWINSPAN analysis of the Military Tract survey data — upland mesophytic, xerophytic, and swamp types — were similar in many respects to the types produced by TWINSPAN in Seischab's analyses (1990, and present volume).

One of the earliest vegetation maps of New York, based on climate and topography, was that of Bray (1930), who showed sugar maple, beech, yellow birch, hemlock, and white pine on the Allegheny Plateau, and chestnut, oaks, hickories, and tulip-poplar on the Lowland. Our data do not support Bray's depiction of a chestnut/oak forest north of the Finger Lakes on the Ontario Lowland, within the region of the Military Tract. However, Bray included narrow margins along Seneca and Cayuga Lakes in this type. In the Military Tract records, oak forests did indeed occur there, but oaks, hickory, pines, and chestnut occurred in a broader band between the lakes than mapped by Bray.

A map of "primeval forests" in New York adapted from R. H. Smith (Hamilton *et al.* 1980), based on survey records and historical accounts, also showed Oak-Hickory along the west/southwest facing lake slopes, and the area of oak and hickory with other hardwoods across the upland between Seneca and Cayuga Lake. In this map, as in our results, there was no strong division between the two physiographic regions: in the area of the Military Tract a Central hardwoods type was shown extending from the Lowland onto the Plateau, with Northern hardwoods to the southeast, Hardwoods-Oak-Chestnut to the southwest, and hemlock and swamps more common to the north.

Braun (1950) described her Oak-Chestnut association extending north from the Appalachian Mountains into central New York along the Susquehanna River drainage. The more detailed information available from the survey records of the Holland Land Company (Seischab, present volume), Phelps and Gorham (Seischab 1990), and Military Tract supports Braun. Within these three areas the distribution of oaks, chestnut, and pines in the late 1700s was primarily southern, although they also occurred on coarse glacial deposits near Lake Ontario (Shanks 1966; Seischab 1990, and present volume). The distribution of oak forests in central and western New York based on survey records agrees well with Küchler's (1964) reasonably detailed map of forest types. In the Holland Land Company tract in western New York two hundred years ago, surveyors reported oak forest primarily in the south, along the Allegheny River drainage (Seischab, present volume). Coming east the next major concentrations of oak forest ranged northward across the Phelps and Gorham Purchase (Seischab 1990). The oak forests west of Seneca Lake (Seischab 1990) continued east into the adjacent western part of the Military Tract, then gradually disappeared along successive Finger Lakes.

Several factors appear to correlate with the distribution of oak forests in the Military Tract and may help explain the distribution. The first is temperature, since the oak forests in the southwestern part of the Military Tract are at the northern edge of a range that is more centrally Appalachian (Braun 1950, Küchler 1964). Oak forests within the Military Tract occurred primarily in the western half, where lower elevations, flatter topography, and the large Finger Lakes may, as Bray (1930) suggested, combine to produce a warmer climate than on the hillier plateau to the east. The second factor possibly contributing to the distribution of the oaks and related species is the continuity of habitat to the south afforded by the Susquehanna River and its many tributaries (Braun 1950). Favorable habitat for oak forest is provided by the relatively steep slopes, particularly of southern aspect, of river bluffs.

Soils and topography are also potential factors, since oak forests are often associated with xeric conditions such as gravelly or well-drained soils (Braun 1950) or ridgetops (Whitney 1991). Soils with shallow bedrock or fragipans can also be droughty, because of the restricted rooting depth (Spurr and Barnes 1980). However, the soils along the western and southern end of the Military Tract in the region where oaks and hickory were recorded were usually silt loams, not particularly xeric or shallow (USDA 1972, Cline and Marshall 1976), on the flat or moderately sloped upland between Seneca and Cayuga Lakes. This suggests that soils were not the primary factor here.

Fire would also favor oaks, which are vigorous sprouters. Earl L. Stone, Jr. (Dept. of Soil Science, University of Florida; pers. comm.) noted that in an oak forest in Cayuga County the canopy trees dated from the late 1700s, while the younger midstory and understory trees were primarily sugar maple and ash. Stone feels that the most plausible explanation for this former predominance of oak in an area that supports mesophytic forest was frequent burning by Native Americans. This is discussed further in the section on disturbance, below.

Soils

Several species showed some association with soil type, although our data were not analyzed at the level of detail necessary to make strong correlations. There was a notable hole in the distribution of black ash just south of Lake Ontario, in the only area of acidic soils north of the Allegheny Plateau (Sodus-Ira associations, Cline 1961). Similarly, only a few black ash were recorded in the southeast in the hilly region of acidic soils (Lordstown-Mardin-Volusia soils). At the scale of Cline's map (1961), cedar, i.e., *Thuja*, occurred on high lime soils.

Walnut appeared to be associated with the calcareous soils between Seneca and Cayuga Lakes (Cline 1961), but was not recorded on similar soils further east. However, walnut is at the northern edge of its range, and the population shown to the east in Little's atlas (1971) is in an area for which we did not have records, the Onondaga Reservation. Moreover, Native Americans may have influenced its distribution in this region, by planting black walnut (Wykoff 1991). Although walnut and hickory were much less abundant than oaks, the similarities in distribution suggest that climate and topography may have been as consequential as soils in determining their distribution.

At the western edge of the Military Tract approximately 10 km north of Seneca Lake is a mixture of sandy well-drained and moderately well-drained soils (Arkport-Claverack; USDA 1972), with pockets of poorly drained soils where clay underlies the sand. This was the patch where scrub oak, huckleberry, pitch pine and white pine, and swamps were recorded. The mosaic distribution of dry and wet soils, probably aided by fires in the uplands, in this case seems to have caused a corresponding mosaic of dry and wet vegetation types. Two mentions of "plain" that occurred nearby may have been on sandy soils, but because of the small-scale heterogeneity here we were not able to precisely match the surveyors' distances with a particular type on the USDA (1949) soils map. The plain with "a few scattering oak" suggests a grassy area similar to the oak openings described by Shanks (1966) in Monroe County, west of the Military Tract.

Species abundances

Beech was extremely common, as it also was further west in New York (Seischab 1990, and present volume) and in Pennsylvania (Whitney 1990). Maple, including sugar maple, and linden (basswood) were also abundant. While these taxa were recorded on a majority of the bounds, the most common witness trees were beech, maple, and hemlock. In the Phelps & Gorham and Holland Land Company tracts (Seischab 1990, and present volume), basswood had high relative frequency on survey lines but was lower in relative species weight, which was based on the order that surveyors listed co-occurring species. This supports the idea that in the Military Tract basswood was underrepresented as a witness tree, compared to its frequency of bounds, because it occurred at lower densities than the beech and maple trees in the same forests.

Based on the survey records, black ash swamps appeared to have been much more frequent 200 years ago. Swamps with black ash as the leading dominant are uncommon in the Finger Lakes region today. Mohler (1991), in his analysis of modern vegetation types in this region, did not recognize a black ash swamp type. Peattie (1966) commented that large black ash trees are now seldom seen.

There were a few native species of canopy trees present in the region (Clausen 1949) that were not referred to by the surveyors. None of these are common species. There were no mentions of cucumber tree, *Magnolia acuminata*, a species listed in the survey records from western New York (Seischab 1990, and present volume). Although it is possible some Military Tract surveyors included it in "lyn," since yellow or black linn are names for *M. acuminata* (Britton and Brown 1913), when Pursh travelled through this region in 1807, he remarked that *M. acuminata* was "very scarce about here" (Beauchamp 1923). Red pine (*Pinus resinosa*), which was not mentioned specifically (but may have been included in "pine"), occurs as natural populations in the southwestern part of the study area (Cook *et al*. 1952). Possibly "spruce" included balsam fir, *Abies balsamea*, which was not mentioned by name but is found in swamps in this area (Wiegand and Eames 1926). The likelihood that yellow birch (*Betula alleghanensis*) was included in "birch" has already been discussed.

Disturbance and other open areas

In the 1790s the major causes of natural disturbance to the forests in the Military Tract were fires and windstorms. It was not possible to determine the extent to which the fires were set by humans or lightning; both were probable causes. Fires were only recorded in the western end of the tract, primarily in the region of oak forest, on both the Ontario Lowland and the Allegheny Plateau. Areas of blowdown, on the other hand, were in mesophytic forest to the south and east on the Plateau. Disturbance was also a factor in wetlands. Beaver dams were recorded in marshes, swamps, and a meadow, and in the Finger Lakes region today, alder thickets are commonly associated with former beaver dams (P. L. Marks, pers. obs.). While most of the wetlands were primarily due to drainage and topography, the impact of beavers on the landscape would have been greater in the centuries prior to trapping for the fur trade. By the 1700s beaver populations in this region were severely depleted (Morgan 1868).

Most of the windfalls appeared to be small patches caused by thunderstorm downbursts. The blowdown 0.2 to 0.4 km wide, which intersected bounds on adjacent lots across a distance of >6 km, was potentially the linear track of a large tornado, like the recent Tionesta blowdown in Pennsylvania (Peterson and Pickett 1991). Alternatively, it may have been multiple patches of windfall from thunderstorm downbursts, which tend to be wider than tornado swaths (Canham and Loucks 1984, Fujita 1985).

In the survey records from western New York (Seischab and Orwig 1991), as in the Military Tract, windfalls were exclusively on the Plateau. Seischab and Orwig suggested that the greater topographic relief on the Plateau than the Lowland may promote greater air turbulence, and that most of the blowdowns were probably from winds associated with thunderstorms and weather

fronts. Because windfalls were more abundant in the eastern tract (Phelps and Gorham) than in the western (Holland Land Company), they proposed that hurricanes coming up the Atlantic Coast might also be a factor. The trend of increasing windfall frequency did not continue eastward into the Military Tract, where many fewer blowdowns were recorded.

The percent of surveyed distance recorded in windfalls in the Military Tract was quite low, only 0.17%, especially compared to other studies in the northeast that are based on survey records (made between 1788 and 1859). For the two tracts in western New York, Seischab and Orwig (1991) reported windfalls on 1.53%, and 0.47%, of the surveyed distance on the Plateau. If these figures are converted to the entire surveyed distance (i.e., Plateau plus Till Plain), they are still higher (0.9% and 0.3%) than in the Military Tract. In hemlock-hardwood forest on the Allegheny Plateau in Pennsylvania, windfalls were recorded on 1.4% of the number of lines surveyed (Whitney 1990), compared to 0.5% of the number of bounds in the Military Tract. Windfalls were more common in lower Michigan, on 0.7% of the total distance (Whitney 1986), and even more so in Maine, on 2.6% of the distance (Lorimer 1977).

"Return time" is the time it would take for the entire distance of survey lines to be affected by disturbance, assuming the current proportion is representative. This is estimated by dividing the probable number of years that disturbances would remain visible (e.g., 15 years) by the percent of surveyed distance in disturbance at a given time. Windfall data from the Military Tract survey records give an estimated return time of about 9000 years, assuming the nearby brushy thickets were also windfalls. Return time estimates based on survey records depend both on how typical the period was during the survey and how many of the actual disturbances the surveyors recorded (Whitney 1986). Even return times of 9000 years should not be construed to indicate catastrophic windstorms are that rare. Immediately to the east of the two windfalls recorded in Ulysses in the 1790s, in 1989 a severe windstorm hit Smith Woods and nearby forests.

The quite small proportion of the survey lines reported in windfalls, with the consequently quite long return time, indicates that large windstorms had only a minor influence on the landscape of the Military Tract in 1790. Regeneration of the forest would only occasionally have occurred in openings larger than a few hectares caused by catastrophic winds. Instead, the vast majority of forest regeneration occurred in much smaller canopy gaps, which would not have been noticed or recorded by the surveyors.

It is much less clear how much of the landscape was affected by fire, since fire probably interacted with soils and vegetation, and since open woods and brushy or stunted vegetation may have burned long enough prior to the survey to not be noticeable as "burnt land." Day (1953) noted that repeated fires can result in "scrubby" oak vegetation. Seischab and Orwig (1991) reported pitch pine on 2.45% of the distance in the eastern of their two tracts and suggested that this represented fire-related vegetation. Pitch pine in the Military Tract was only mentioned once adjacent to a burn. Areas referred to specifically as due to fire were as uncommon in the survey records of the Military Tract, with 0.1% of the surveyed distance in burns, as in other regions of hardwood forest. Only one burn was reported in the two tracts in western New York (Seischab and Orwig 1991), and none in the Pennsylvania study (Whitney 1990). In contrast, conifer forests in Michigan (Whitney 1986) and Maine (Lorimer 1977) had burns recorded on 7 to 9% of the surveyed distance.

The several types of dry open habitat recorded in the Military Tract included areas likely to have been fire-related. One of these was the band of open oak plains north of the Seneca River. Although these suggest oak openings on xeric soils similar to areas described by Shanks (1966) west of the Military Tract, at least 3 of the 5 bounds with open plain near the Seneca River were on silt loams (USDA 1972), soils capable of supporting closed forest. Dudley's interpretation (1886) of historical accounts of this region was that grassy plains with scattered oak could be created by fires set by the Iroquois to drive deer, and perhaps also by clearing for fields. As a road ran through this area, and there was an Iroquois village here (Scawyace, whose cornfields were destroyed by Sullivan's army in 1779; Cook 1887), it is likely that this open land was created or maintained by repeated fires, rather than being edaphic prairie.

We suggest that fire may also have been a factor in open or scrubby oak woods. These often occurred on gentle slopes with aspects and soils that would not, by themselves, have produced the distinctive physiognomies described by the surveyors. Some of the occurrences of "open oak woods," "scrubby oak ridge," and "thick underbrush" along Seneca Lake and south of Cayuga Lake were near Iroquois roads or villages, suggesting that these may have been created by fires, which may have been used here to drive deer (Morgan 1901) or to clear brush from the road (W. Wykoff, pers. comm.). Whitney (1990) commented on the likely relationship between fires, some set by Seneca Indians, and the brushy oak and chestnut ridges along the Allegheny River in Pennsylvania. However, in the Military Tract some of the open woods, brushy or scrubby areas, and pitch pine were on ridges or steep south- or west-facing slopes, and could have been due to droughty soils.

If one assumes, arbitrarily, that half of the bounds distance in scrub, open woods, and open plains was due to fire, the estimated return time for fire would be about 2600 years. Restricting the calculation to the <15% of bounds in oak or pine forest, where most of the fires and dry open areas occurred, would produce a much shorter return time. However, such a figure would underestimate return time due to natural fires (lightning strikes), since many fires were probably set by people.

The surveyors traversed the landscape of the Military Tract at a period of transition in terms of human impact. The effects of European diseases, wars, and the Sullivan expedition had all but eliminated Iroquois populations from the region of the Military Tract (Peirce and Hurd 1879, Thompson 1966). On the other hand the rapid influx of settlers with their enormous effects on the landscape had not quite begun. Thus in 1790 the surveyors would have seen a landscape being less actively influenced by people than both earlier and later. Still, effects of people were

evident, primarily from previous Iroquois activities. The introduction of European crops and domestic animals into the region had already begun by the time of the survey (Norton 1879). As early as 1807, Pursh commented on the European weeds growing along the road east of Cayuga Lake (Beauchamp 1923).

During the Late Woodland Period (ca. 1000 to 1600), Native American villages, camps, and other areas of activity were scattered both across the northern half of the central Finger Lakes region and also near Seneca and Cayuga Lakes (Hasenstab 1990). The Onondagas had large fields of corn in the 1600s in what was later the township of Pompey (Day 1953), near where "old clearings" were recorded by the surveyors. Other villages that had been to the southwest and south of Oneida Lake (Beauchamp 1905) were in areas for which we did not have survey records (Manlius and the Onondaga Reservation).

In 1779, a decade before the tract was surveyed, the Iroquois villages and crops that Sullivan's army found along the Seneca and Cayuga Lakes were destroyed, including Kendaia and its apple orchards (Norton 1879, Cook 1887). The area of "ancient" "improvements" by Cayuga Lake, near the present town of Aurora, had been the site of Chonodote, a small Cayuga village with cornfields and peach orchards (Norton 1879, Cook 1887). Coreorgonel, a village of 25 houses at the south end of Cayuga Lake (on the upland just southwest of the cleared flats mentioned in the survey records) was also destroyed (Cook 1887).

In the centuries prior to European contact, effects of Native Americans on vegetation and the landscape would have included clearing fields for corn and other crops, and cutting wood for houses and fuel (Beauchamp 1905, Day 1953). These activities would have been concentrated near villages, but areas as large as 50 ha could be affected (Day 1953). Among the woody species used for food which may have been planted near villages were black walnut and plum (Hedrick 1933, Wykoff 1991).

The Iroquois would also have had effects on the vegetation through their use of fire. Some of the eight areas noted by the Military Tract surveyors as "burnt" may have been due to Native Americans; other burns may date from the Sullivan campaign in 1779. Day (1953) and others have reviewed the potential impacts of Native Americans on the landscape, but it still remains unclear to what extent fires set by people, clearing for fields, or the cutting of wood were involved in the open oak areas. However, the Iroquois would have had more effects on the vegetation of the region than is reflected in the surveyors' scanty list of "old clearings."

Conclusions

1. *The central Finger Lakes landscape in the 1790s.* Over 97% of the distance of lot boundaries in the survey records from the Military Tract was in forest. Disturbance and wet or dry open areas were recorded on only 2.8% of the surveyed distance.

2. *Species abundances.* The predominant forest type, found throughout the region both on the Allegheny Plateau and on the Ontario Lowland, was Beech-Maple-Linden (i.e., basswood). These three were the most common taxa recorded along lot boundaries. The most common witness trees at lot corners were beech, maple (including sugar maple), and hemlock.

3. *Regional differences.* Tree species with less widespread distributions tended to occur in one of three general areas of the Tract. Swamp species such as white cedar were found predominantly in the lowlands to the north. Black cherry and birch were recorded primarily on the higher elevations to the southeast. Oak, hickory, and pine tended to occur to the south and west of the Tract, along the larger Finger Lakes.

4. *Swamps.* Forested swamps were especially abundant on the Ontario Lowland. Black ash swamps were the most common.

5. *Natural disturbance.* Relative to similar studies of survey records from other parts of northeastern U.S.A., the Military Tract had the smallest fraction of distance in windfalls, burns, or flooded by beaver dams: 0.3%. These disturbances were recorded along short distances on boundaries, often <0.8 km, but one blowdown track was >6 km long.

6. *Other openings in the forest.* Marshes were common on the Ontario Lowland. Other wet open areas were meadows and alder thickets. Open oak plains were recorded north of the Seneca River. Open, scrubby, and brushy oak or beech woods occurred on the uplands between Seneca and Cayuga Lakes and to the south.

7. *Human impact.* Former clearing by Native Americans, and settlers' homes and agricultural fields, were very sparse. Only 24 were mentioned in the >4000 bounds described. The 1790s were a period of particularly small population in the townships for which we had survey records. Effects of the Iroquois on the landscape, including oak areas possibly kept open by fire, would have been greater in earlier times.

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Forests of the Holland Land Company in Western New York, circa 1798

Franz K. Seischab

Abstract: In 1798 forests of the Allegheny Plateau, in western New York, supported a section of the Hemlock-White Pine-Northern Hardwoods Forest. These were primarily beech-maple-hemlock communities but oak, oak-chestnut, and hemlock communities also occurred on the Plateau, principally in the southern part of the tract. The Till Plains of the Central Lowlands Province was part of the Beech-Maple Forest region. The upland forests of the Till Plains were mainly beech-maple, the bottomlands mostly black ash-elm-silver maple swamp forests. A scattering of grassland or "plains" occurred in the forest matrix of the Till Plains. Most upland mesic forests contained beech, sugar maple, or hemlock but other mesic forests of oak, basswood, and magnolia occurred. Dry-mesic forests on upper slopes contained oak, beech, and red maple. Wetland forests were of black ash-silver maple-elm, alder, or northern white cedar-larch-alder, some with black spruce.

Introduction

A considerable body of information has been gathered on the forests of the northeastern United States at the time of European settlement. In New England, Lorimer (1977) examined forests of Maine, circa 1793. The species composing greater than 10% of the witness trees in these forests were spruce, beech, balsam fir, northern white cedar, and yellow birch with hemlock also important in the southern portion of the tract examined. Whitney and Davis (1986) examined the forest history of Concord, Massachusetts from 1652 to the 20th century. They showed that the present white pine-northern red oak-red maple forest is the result of succession following various kinds of disturbance. Loeb (1987) examined witness trees and showed southeastern New York and northeastern New Jersey to have been dominated by white, red, and black oak, hickory, and chestnut. In southeastern New Jersey, oak, pine, Atlantic white cedar, and maple dominated.

In the Green Mountains of Vermont, Siccama (1971) showed beech to be the dominant on upland mid-elevation soils with spruce-fir domination at higher elevations. Further west, in the forests of the Catskill Mountains of New York, McIntosh (1962) found low and mid-elevation forests to have been beech-hemlock-sugar maple-birch.

In central-western New York, Seischab (1990) found a difference between the 1790s forest on the Till Plains of the Central Lowlands and that on the Allegheny Plateau. The Beech-Maple Forest on the Till Plains was dominated by beech, sugar maple, basswood, elm and ash whereas the Hemlock-White Pine-Northern Hardwoods Forest on the Allegheny Plateau was dominated by beech, sugar maple, hemlock, white pine, white, red, and black oak. Gordon (1940), examining the primeval forests of Cattaraugus Co. in southwestern New York, described a forest responding to a topographic-moisture gradient. He also described wetland forests of white pine-American elm and black spruce-tamarack. He found that bottomland forests were composed of cottonwood, sycamore, elm, silver maple, and black willow. He described the low elevation upland forests as beech-sugar maple and mixed mesophytic forest and oak-chestnut as being on upper slopes and ridges.

East of the Phelps and Gorham Purchase in the Military Tract, Marks and Gardescu (present volume) found that beech, maple, basswood, and oak were the most common species on the Allegheny Plateau and beech, maple, basswood and hemlock were most common on the Ontario Lowland. Black ash was much more abundant on the Lowland while the oaks were somewhat more abundant on the Plateau. They found that the wetland species, alder, white cedar, and tamarack were more abundant in the Lowland as were swamps and marshes.

Nearby on the Allegheny Plateau in northwestern Pennsylvania, Lutz (1930) and Whitney (1990) noted the occurrence of forests of beech and hemlock on mesic sites and outliers of oak forests on xerophytic sites, i.e., upper slopes, stony soils, and soils with a fragipan.

Study Area

The Holland Land Company acquired, divided and sold most of the land between 78° and 79° W in New York State (Fig. 1). This 12,950 km^2 area lies between Pennsylvania and Lake Ontario and is bordered on the west by Lake Erie and the Niagara River. Beginning in 1798 the tract was divided into ranges 6.4,

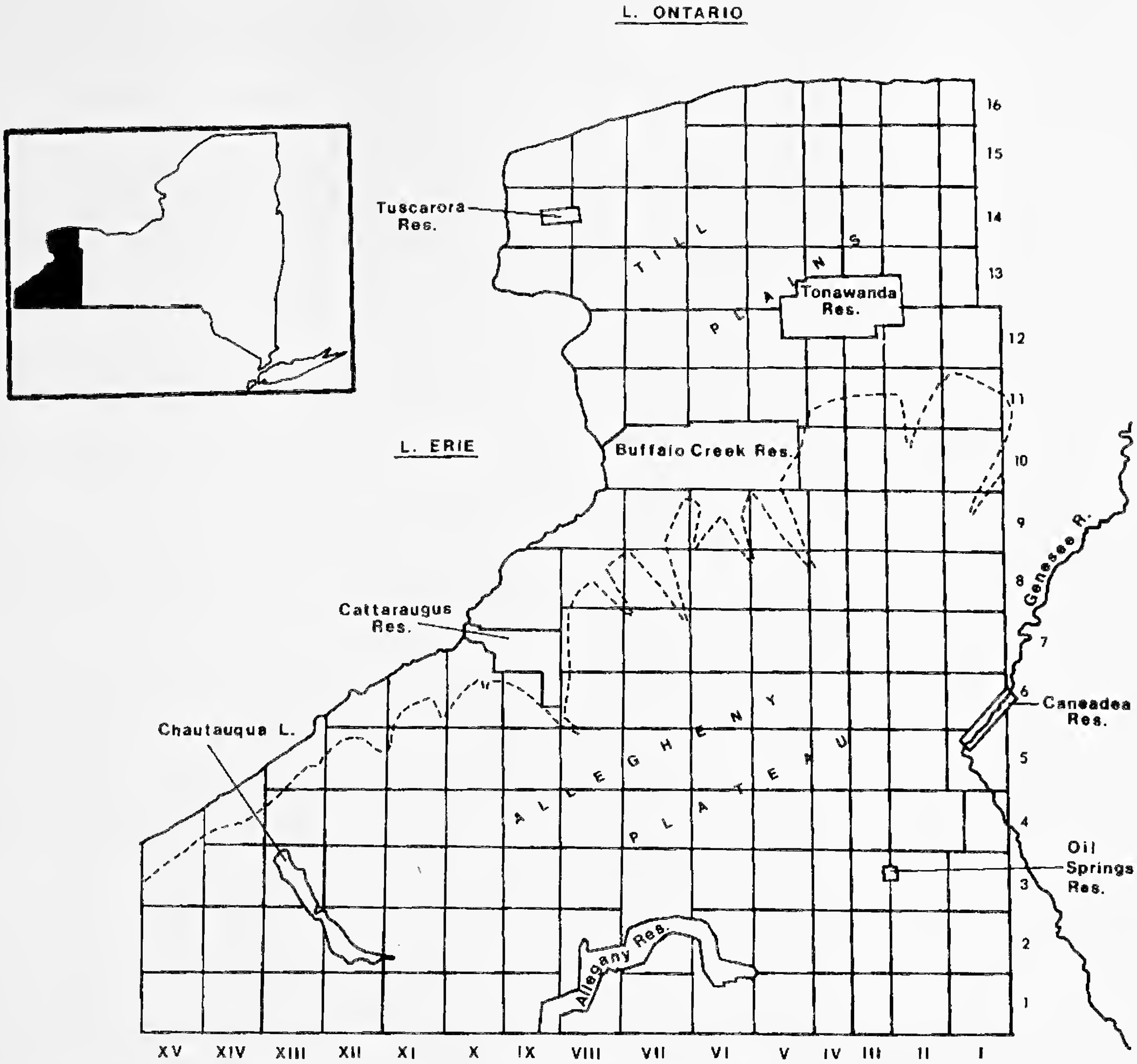


Fig. 1. A map of the Holland Company lands in western New York State. Ranges are indicated in Roman numerals. Township numbers are to the right. The dashed line represents the boundary between the Till Plains of the Central Lowlands and the Allegheny Plateau physiographic provinces.

9.6, or 11.1 km (4, 6 or 7 miles) wide and townships 9.6 km from south to north. The Buffalo Creek, Tonawanda, Cattaraugus, Allegany, Caneadea, Tuscarora, and Oil Springs Indian Reservations were established within this tract.

Agents for the Holland Land Company were more precise than previous surveyors in New York State. They used transits rather than hand held compasses and increased the accuracy of the survey by employing axemen to remove trees along the line of sight. All notes of survey were rewritten and sent to the owner bankers in Amsterdam, Holland.

These records are stored in the Municipal Archives of Amsterdam. In 1976 the Archives completed and published the *Inventory of the Archives of the Holland Land Company* (Pieterse 1976). Included in these materials is a complete set of survey notes of the Holland Company lands. The above records are on microfilm at the Holland Land Company Project at the State University of New York College at Fredonia. A description of this project can be found in Safran (1988).

The purpose of this study was to: 1) use the survey notes to reconstruct the vegetation of the 1798 forests of the Holland Land Company; and 2) compare and contrast the results with earlier studies in adjacent areas.

Methods

Survey notes provide two kinds of vegetation information: bearing tree data and line descriptions. In the Holland Company survey, information on two bearing trees was provided at the end of each mile and four trees at each of the four corners of each

Table 1. A. Initial species weight of the leading species in the survey notes list. B. Species weights based on the niche preemption hypothesis as described in the text. If a sample contains four species then the first species has a value of 40, the second 24, the third 14.4 and the fourth 8.6. C. Relative species weights.

A.

	Number of Species								
	1	2	3	4	5	6	7	8	9
Initial Weight	100.0	66.7	50.0	40.0	33.3	28.6	25.0	22.2	20.0

B.

	Number of Species								
	1	2	3	4	5	6	7	8	9
Species Weights	100.0	66.7	50.0	40.0	33.3	28.6	25.0	22.2	20.0
		22.2	25.0	24.0	22.2	20.4	18.8	17.3	16.0
			12.5	14.4	14.8	14.6	14.1	13.4	12.8
				8.6	9.9	10.4	10.6	10.5	10.2
					6.6	7.4	7.9	8.1	8.2
						5.3	5.9	6.3	6.6
							4.5	4.9	5.2
								3.8	4.2
									3.4

C.

	Number of Species								
	1	2	3	4	5	6	7	8	9
Relativized Species Weights	100.0	74.8	57.3	46.0	38.4	33.3	28.8	25.6	23.1
		25.2	28.6	27.6	25.6	23.5	21.6	20.0	18.5
			14.3	16.6	17.1	16.8	16.2	15.5	14.8
				9.9	11.4	12.0	12.2	12.1	11.8
					7.6	8.5	9.1	9.4	9.5
						6.1	6.8	7.3	7.6
							5.1	5.7	6.1
								4.4	4.8
									3.9

township. In a 6 X 6 mile (9.6 X 9.6 km) township, this would be a sample of 56 trees for a 93 km^2 area or 0.6 tree/km^2, a rather sparse sample. However, line descriptions provide tree species lists for several segments of each surveyed mile. Thus a larger number of species, representing a greater number of individuals, is provided for each surveyed mile by line descriptions than by bearing tree descriptions. These are the most important data used in reconstructing the forests at the time of the original surveys.

I assumed that species recorded in the line descriptions were arranged in order of their importance or abundance. This is reasonable, since humans tend to itemize objects in descending order of size, number, volume, or importance. By 1804 Federal surveyors in the Midwest were instructed to list tree species in this manner (White 1984).

If species are listed in order of importance they can then be quantified to approximate that importance. This is because the 5 or 6 most important tree species in a community invariably approximate a linear dominance-diversity relationship. This was shown by Whittaker (1975) for a species poor subalpine forest and for trees in the Brookhaven oak-pine forest (Whittaker 1969). Bazzaz (1975) reported on a forty year old successional field in which the most important species formed a straight line dominance-diversity curve. Linear relationships are expected in "small samples from communities for which the curves are sigmoid" (Whittaker 1965) and since species lists from survey notes represent such "small samples" they should exhibit such relationships. Therefore, I assumed that the communities in the survey notes formed straight line dominance-diversity curves.

Each surveyed mile was treated as a linear plot and will be referred to as a sample. Relative species weights (RSWs) for each species in each mile were calculated as follows. Species were weighted from last to first, in numerical order from 1 to i, as listed by the surveyor. The relative weight of the first species was initially approximated as that species abundance (Table 1A). First approximations for the remaining species in the list were determined based on the fundamental supposition of the niche-preemption hypothesis, namely, that each successive species allocates the same proportion of the remaining resources as the most important species allocated for itself (Table 1B). Final approximations were determined by relativizing the first approximations (Table 1C). These relative species weights form straight line dominance-diversity curves as described earlier.

The RSWs, in Table 1C, were used to generate a species by mile data matrix of RSWs based on species lists in the survey notes. For example, if a surveyor listed a mile as containing beech, sugar maple, basswood, and white ash, these species were assigned RSWs of 46.0, 27.6, 16.6, and 9.9 respectively (Table

1C). In another mile a surveyor may have listed the above species in the first half mile and white oak, black oak, and hickory in the second half. In this case beech, sugar maple, basswood, and white ash would be assigned RSWs of half the values seen in column 4, Table 1C, or 23.0, 13.8, 8.3, and 4.9 respectively. White oak, black oak, and hickory would be assigned half the values in column 3, Table 1C, or 28.6, 14.3, and 7.1 respectively. The sum of the RSWs for the mile would be 100.

A species by mile matrix of RSWs was generated as described above and subjected to the classification program TWINSPAN (Hill 1979a), a polythetic divisive technique designed to identify subgroups or communities within large data matrices. Detrended correspondence analysis (DCA) (Hill 1979b) was used in order to detect ecological trends and relationships in the matrix. Relative frequency was determined as the percent of surveyed miles in which a species was recorded in the survey notes. Relative frequency data from the Holland Company survey, the Phelps and Gorham survey (Seischab 1990), and from the Military Purchase (Marks and Gardescu, present volume) were relativized to 100%. These were compared to the witness tree frequency data in the Catskill (McIntosh 1962) and Pennsylvania studies (Whitney 1990, Lutz 1930) using Sorenson's (1948) similarity coefficient: $C = 2W/A + B$, where A and B are the frequencies of all the species found in each of two communities to be compared and W is the sum of the lesser values for the species common to the two stands.

Maps of the relative species weights were generated in order to determine the regional distribution of each of the species.

Vascular plant nomenclature follows Mitchell (1986).

Results

Relative Frequency

Common names of species included in the survey were usually the same as those used today (Table 2). Assumptions were made in the interpretation of some of the common names used by surveyors (Table 2).

The frequency and RSW data sets were divided according to the physiographic provinces in which the samples occurred and are listed in Table 3. Beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*) were the two most widely distributed species with approximately the same relative frequencies on both the Till Plains and the Allegheny Plateau. Mesic and wet mesic species such as elm (*Ulmus*), basswood (*Tilia americana*), white ash (*Fraxinus americana*) and black ash (*F. nigra*) all had greater frequencies on the Till Plains than on the Allegheny Plateau. Those species with greater frequencies on the Plateau than the Plains were hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), chestnut (*Castanea dentata*), yellow birch (*Betula alleghanensis*), and *Magnolia acuminata*. Most species were recorded on both the Allegheny Plateau and the Till Plains. *Quercus bicolor*, *Picea mariana*, *Zanthoxylum americanum*, *Kalmia* sp., and *Abies balsamea* were reported only from the Plateau while *Acer negundo*, *Liriodendron tulipifera*, *Thuja*

Table 2. List of species encountered in the survey notes for the Holland Company Lands.

Species	*Notes of Survey Descriptions*
Abies balsamea	fir
Acer negundo	box elder
Acer rubrum	maple, soft maple[1]
Acer saccharinum	maple, soft maple[1]
Acer saccharum	maple, sugar maple
Alnus incana	alder
Betula lenta	black birch
Betula alleghanensis	birch[2]
Carpinus caroliniana	hornbeam
Carya spp.	hickory
Castanea dentata	chestnut, chesnut
Cornus florida	dogwood
Corylus spp.	hazel
Crataegus spp.	thorn
Fagus grandifolia	beech
Fraxinus americana	ash, white ash
Fraxinus nigra	ash, black ash
Juglans cinerea	butternut
Juglans nigra	walnut, black walnut
Kalmia spp.	laurel
Larix laricina	tamarack
Liriodendron tulipifera	whitewood, tulip tree
Magnolia acuminata	cucumber tree, cucumber
Nyssa sylvatica	pepperidge
Ostrya virginiana	ironwood
Picea mariana	black spruce, spruce
Pinus strobus	pine, white pine
Platanus occidentalis	buttonwood, sycamore
Populus spp.	poplar, aspen, aspine
Prunus serotina	cherry
Quercus alba	white oak, oak[3]
Quercus bicolor	swamp white oak, swamp w oak
Quercus montana	rock oak
Quercus palustris	swamp oak
Quercus rubra	red oak
Quercus velutina	black oak
Salix nigra	willow
Taxus canadensis	shinwood, shin[4]
Thuja occidentalis	cedar[5]
Tilia americana	basswood, lyndon
Tsuga canadensis	hemlock
Ulmus spp.	elm[6]
Vitis riparia	grape, wild grape
Zanthoxylum americanum	prickly ash
Other Designations	
Agricultural fields	fields, cleared
Marsh	marsh, mire, bog
Plains	plains
Rock outcrops	rock bottom
Shrubs	shrubs, brush

[1] Often there was no distinction made between *Acer saccharum* and *A. rubrum* when "maple" was used in the notes of survey. For analytic purposes "maple" was interpreted to mean sugar maple when found in association with beech, basswood, and other mesic species. It was interpreted to have been red maple when found in association with oaks and hickories. When the term "maple" was used in wetland situations in association with elm and black ash it was interpreted as being *A. saccharinum* and as *A. rubrum* when in association with cedar or larch.

[2] Some of the individuals referred to as "birch" may have been *B. lenta*. Although some of the surveyors differentiated between *B. lenta* and *B. alleghanensis* it is not clear that all surveyors made this distinction.

[3] The term "oak" was often used in this survey, an obvious reference to mixed oak stands. It is presumed that these stands contained both white and black or red oaks. For analytical purposes, where "oak" was recorded in the notes of survey both white and either black or red oak was quantified in the data set.

[4] "Shinwood", which appears in the notes of survey, has a single reference to its analogue (Britton and Brown 1913), *Taxus canadensis*, which was brought to my attention by Gardescu (personal communication). Siccama (personal communication) believes this may also be *Amelanchier*, used as a cathartic and referred to as "Shittum wood" in Vermont surveys. From the associated descriptions in the survey records this term was being used to describe a type of shrub and so was most likely *Taxus*.

[5] The notes of survey use the term "cedar", here interpreted as being *Thuja occidentalis* not *Juniperus virginiana* since all the "cedar" references occurred in wetlands in assoeiation with tamarack or black ash.

[6] "Elm" was used in the survey to represent both *Ulmus americana* and *U. rubra* since it occurred in both upland and bottomland forests.

Table 3. Relative frequency and relative species weights for the Holland Company Lands, for the Allegheny Plateau and Till Plains portions of the tract. There were a total of 2049 surveyed miles, 700 on the Till Plains and 1349 on the Plateau.

	Relative Frequency			Relative Species Weight		
	Total	Allegheny Plateau	Till Plains	Total	Allegheny Plateau	Till Plains
Fagus grandifolia	92.5	92.1	93.1	22.4	23.4	20.5
Acer saccharum	83.6	84.5	81.9	20.3	22.6	15.6
Tilia americana	69.0	61.1	84.7	8.2	7.1	10.5
Tsuga canadensis	56.9	64.5	41.9	10.0	11.4	7.3
Ulmus spp.	52.9	43.4	71.6	6.2	4.7	9.1
Fraxinus americana	45.7	33.4	69.7	3.8	2.6	6.3
Quercus alba	30.5	25.7	39.7	3.8	3.6	4.2
Betula alleghanensis	29.9	39.2	11.7	2.7	3.7	0.8
Pinus strobus	25.6	34.2	8.7	3.4	4.7	0.9
Fraxinus nigra	24.1	13.3	45.3	3.6	1.7	7.3
Quercus velutina	20.8	18.3	25.9	2.4	2.6	1.9
Castanea dentata	20.4	25.0	11.4	2.4	3.1	0.9
Acer rubrum	20.1	19.4	21.4	2.2	2.1	2.5
Carya spp.	19.5	7.6	43.0	1.4	0.6	2.9
Magnolia acuminata	17.3	22.8	6.6	1.3	1.8	0.4
Prunus serotina	11.0	16.5	0.3	2.9	1.1	6.4
Populus spp.	9.3	3.9	20.0	0.6	0.2	1.4
Ostrya virginiana	8.5	5.7	14.0	0.5	0.4	0.7
Juglans cinerea	6.7	6.3	7.6	0.5	0.5	0.4
Acer saccharinum	5.6	2.6	11.6	0.6	0.3	1.0
Quercus rubra	4.8	5.2	4.1	0.4	0.5	0.3
Alnus incana	4.2	3.5	5.6	0.4	0.3	0.7
Juglans nigra	3.0	0.7	7.4	0.3	0.1	0.7
Platanus occidentalis	1.9	2.6	0.5	2.8	0.2	8.0
Larix laricina	1.6	0.3	4.1	0.2	<0.1	0.6
Thuja occidentalis	1.5		4.6	0.2		0.7
Salix nigra	1.5	0.3	3.9	0.2	<0.1	0.4
Crataegus spp.	1.4	2.1	0.1	0.1	0.1	<0.1
Liriodendron tulipifera	1.0		2.9	0.1		0.4
Quercus montana	0.9	1.2	0.3	0.1	0.2	<0.1
Quercus palustris	0.9	0.3	2.0	<0.1	<0.1	0.1
Abies balsamea	0.9	1.4		0.1	0.1	
Betula lenta	0.5	0.4	0.6	<0.1	<0.1	<0.1
Shrubs	0.4	0.1	1.1	<0.1	<0.1	0.1
Marsh	0.4	0.2	0.7	0.1	0.1	0.2
Plains	0.3	0.1	0.9	0.1	<0.1	0.3
Kalmia spp.	0.3	0.4		<0.1	0.1	
Carpinus caroliniana	0.2	0.2	0.1	<0.1	<0.1	0.1
Cornus florida	0.2	0.1	0.3	<0.1	<0.1	<0.1
Taxus canadensis	0.2	0.3		<0.1	<0.1	
Acer negundo	0.1		0.3	<0.1		<0.1
Corylus spp.	0.1	0.1		<0.1	<0.1	
Rock Outcrops	0.1		0.1	<0.1		0.1
Nyssa sylvatica	0.1		0.1	<0.1		<0.1
Vitis riparia	0.1		0.1	<0.1		<0.1
Quercus bicolor	0.1	0.1		<0.1	<0.1	
Picea mariana	0.1	0.1		<0.1	<0.1	
Zanthoxylum americanum	<0.1	<0.1		<0.1	<0.1	
Agricultural Fields	<0.1	<0.1		<0.1	<0.1	

occidentalis, and *Nyssa sylvatica* were reported only from the Till Plains.

Relative Species Weights

Relative frequency data are of limited value because they give the impression that the forests in western New York consisted largely of the widely distributed beech-sugar maple-basswood forest. The rank order of the most widespread (highest relative frequency) three or four species and the species with the greatest RSWs are more or less the same. However, the RSWs approximate what McIntosh (1957) described as importance values, a measure of a species density and biomass. Species which are widespread (have a high relative frequency) don't necessarily have high relative densities and/or large relative biomasses.

The relative species weights (RSWs) (Table 3) temper this impression. Five species have RSWs greater than 5%, which is typical of species importance values in numerous temperate forest communities. In this data set beech, sugar maple, hemlock, basswood, and elms have the highest RSWs.

Although beech and black oak (*Quercus velutina*) had greater frequency on the Till Plains than on the Allegheny Plateau their RSWs were lower on the Plains than the Plateau. As with the frequency data sugar maple, yellow birch, white pine, and hemlock had higher RSWs on the Plateau while basswood, elm, white and black ash had higher values on the Till Plains.

Community Organization

Neither the frequency nor the IV data provide information pertaining to the communities found within the tract since both involve summary data. Two-way indicator species analysis

(TWINSPAN) (Hill 1979a) was used to ascertain the community types. Two analyses were performed; one arranged species, the other samples. Communities were named according to the dominant species (those with RSWs of greater than 10%).

The initial dichotomy in the sample dendrogram (Fig. 2) separated 1,889 samples with beech, sugar maple, and wetland components from 160 samples with oak affinities.

The 1,889 samples were further subdivided into those with wetland components and those from upland mesic sites with beech-sugar maple-hemlock forests. All of the wetland sites contained black ash. Most of the bottomland communities were hemlock-black ash-yellow birch-white pine forests. Eleven samples were in black ash-alder (*Alnus incana*)-elm, eight in northern white cedar (*Thuja occidentalis*)-larch (*Larix laricina*)-alder bottomland forests and three were described by surveyors as black ash swamp containing northern white cedar and white pine.

The most widespread community type was the beech-sugar maple-basswood-elm-hemlock upland forest (1325 samples, 65% of the area). The other beech-sugar maple samples contained components of either oak and white pine or hemlock and yellow birch.

Of the 160 samples (7.8% of the total) with oak affinities, 112 (5.5%) contained mesic species such as sugar maple, basswood, and *Magnolia acuminata* and 48 (2.3%) dominated primarily by oaks. This separation is in part due to the way in which samples were established. A surveyed mile could include mesic communities of beech, sugar maple, or *Magnolia* as well as oak-dominated communities on dry-mesic sites. Although these communities existed on slightly different sites, both were often encountered in the same surveyed mile and, therefore, were combined in the present analysis.

Fig. 3 shows the distribution of communities identified by TWINSPAN analysis. The beech-sugar maple-white ash-elm-hemlock communities (No. 0) were located throughout the tract occurring in almost all of the townships. Those communities with a large component of elm, silver maple, and black ash (No. 2) were concentrated in the northwest quadrant of the tract. A concentration of communities containing black ash, northern white cedar, larch, white pine, and alder, occurred in townships 13 and 14 in ranges I and II (No. 9 in Fig. 3). Today this area includes the Oak Orchard Swamp and the Elba mucklands. A rather large black spruce (*Picea mariana*) swamp existed in townships 4 and 5 in range IX (No. 5 in Fig. 3). This is the Conewango Swamp described in Gordon (1940).

Oak-dominated communities were located in the southeast corner of the tract. A concentration of communities with large components of chestnut and hemlock (Nos. 3, 4, 6, 11 and 13) occurred in the area of the Allegany Reservation. Areas described as "plains" or grassy areas (Range VI and VII, town-

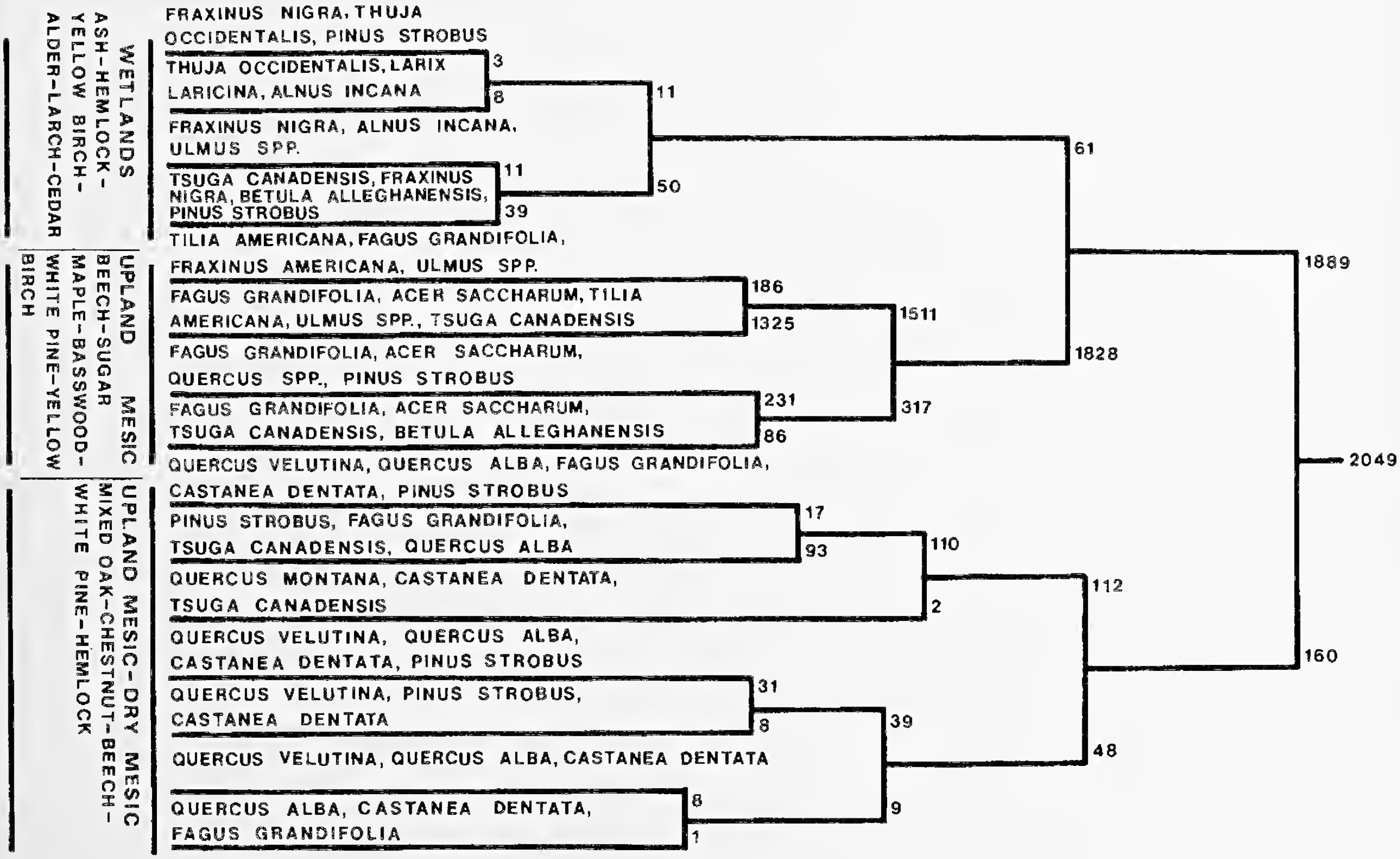


Fig. 2. A dendrogram showing the classification of 2049 surveyed miles. Communities were found in wet and wet-mesic bottomlands, upland mesic, and upland dry-mesic sites. The number of samples included and the dominant species in each community are indicated.

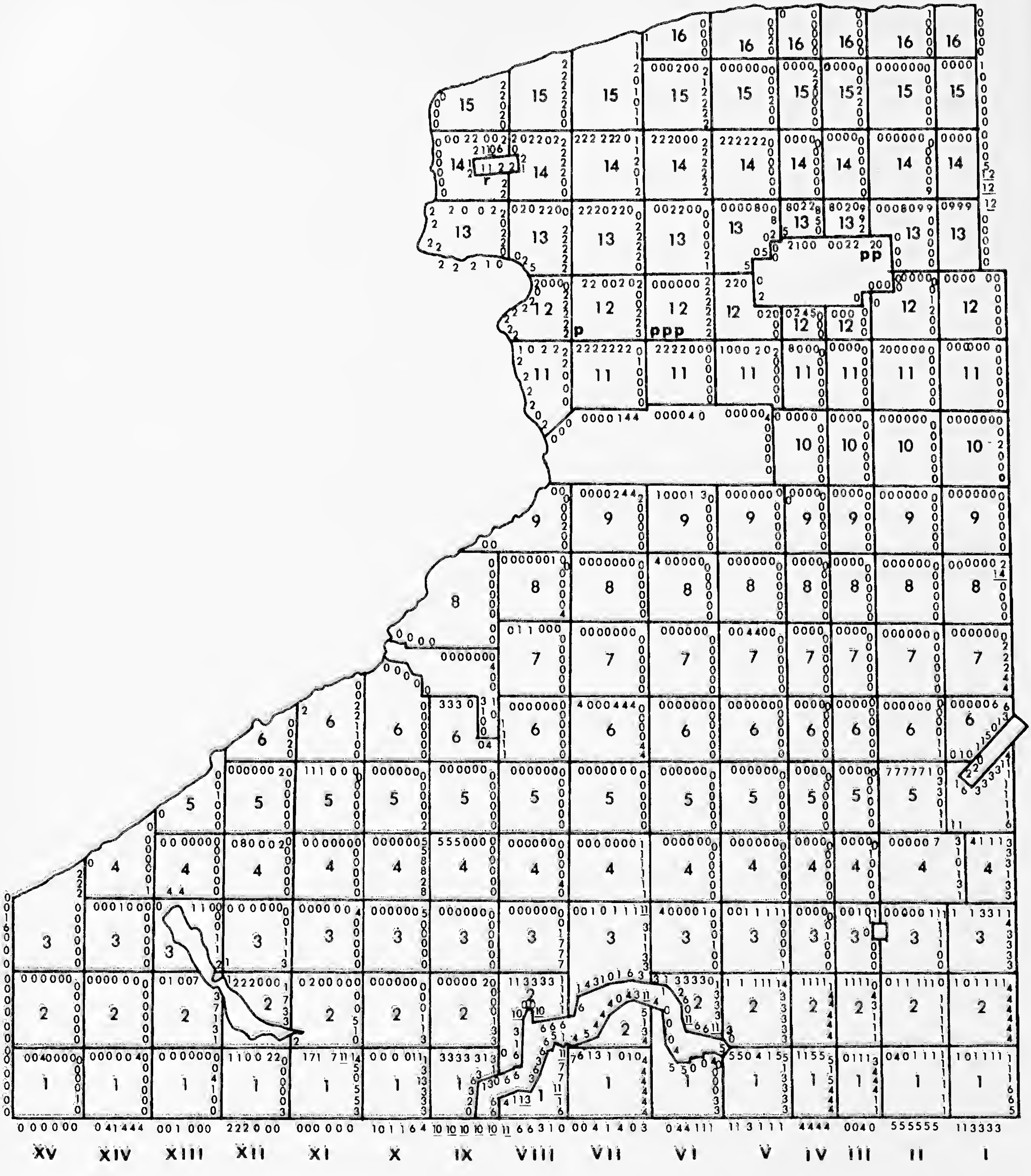


Fig. 3. A map of the community types identified in the sample TWINSPAN analysis (Fig. 2). Large numerals indicate township numbers. Smaller numerals indicate community types shown in Fig. 2 and are designated as follows: 0, beech-sugar maple-white ash-elm-hemlock; 1, beech-sugar maple-oak-white pine; 2, basswood-beech-white ash-elm; 3, white pine-beech-hemlock-white oak; 4, beech-sugar maple-hemlock-yellow birch; 5, hemlock-black ash-yellow birch-white pine; 6, black oak-white oak-chestnut-white pine; 7, black oak-white oak-beech-chestnut-white pine; 8, black ash-alder-elm; 9, northern white cedar-larch-alder; 10, black oak-white pine-chestnut; 11, black oak-white oak-chestnut; 12, black ash-northern white cedar-white pine; 13, chestnut oak-chestnut-hemlock; 14, white oak-chestnut-beech. P designates the location of "plains" and R the location of rock outcrop.

ships 11 and 12); some as being "thinly timbered" and in the literature as "oak openings" (Seischab and Orwig 1991) existed (Fig. 3). Most of these sites were grasslands on droughty soils. Such a site still exists in township 12, Range VII and is on droughty Wassaic soils, 50-70 cm in depth, overlying limestone bedrock. Vegetation surrounding these "plains" were described as a mixture of white, black, and red oak, hickory, "Aspine", ash, ironwood, sugar maple and basswood. Two of these "plains" were described as being "thinly timbered" with the aforementioned species. Another area (Ranges II and III, township 13) described as "plains" was at the edge of the Tonawanda Reservation and was probably an anthropogenic disturbance since that portion of the site which is not presently in agriculture supports vegetation which is clearly mesic (personal observation). A region described as "rock bottom", assumed to be a rock outcrop, was recorded from township 14, range IX.

The species TWINSPAN classification (Fig. 4) resulted in similar community assemblages. The species were grouped into those which occurred on dry-mesic uplands, in wetlands, in wet-mesic bottomlands, or in mesic uplands. These assemblages corroborate the findings based on the sample classification.

Species Distributions

The distribution of several species is clearly associated with the origin of the underlying soils (Fig. 5). Glacial deposits are the main parent materials in this section of western New York (Cline and Marshall 1977). These include glacial till and outwash, deltaic sands, and sediments in former glacial lakes. In addition, on the Genesee-Orleans County line is an accumulation of organic soils, primarily Carlisle Muck. These histosols formed in the Salina Trench, a depression found between the Niagara Escarpment to the north and the Onondaga Escarpment to the south (Fairchild 1928). Lacustrine deposits are concentrated in Niagara and Erie counties in the northwest corner of the area as well as in glacial valleys, in the southern half of the area, which supported lakes as the glacier receded.

Maps of the relative species weights (RSW) were completed (Fig. 6.1—6.12) with circles representing each mile in which a species occurred. The size of the circle indicates the RSW of the species in any particular mile.

Several patterns of species distribution are evident in the maps. The widely distributed beech, sugar maple, and basswood exemplify the first pattern. These occurred on almost all soil types. Beech (Fig. 6.1) reached its greatest RSW at the northeast-

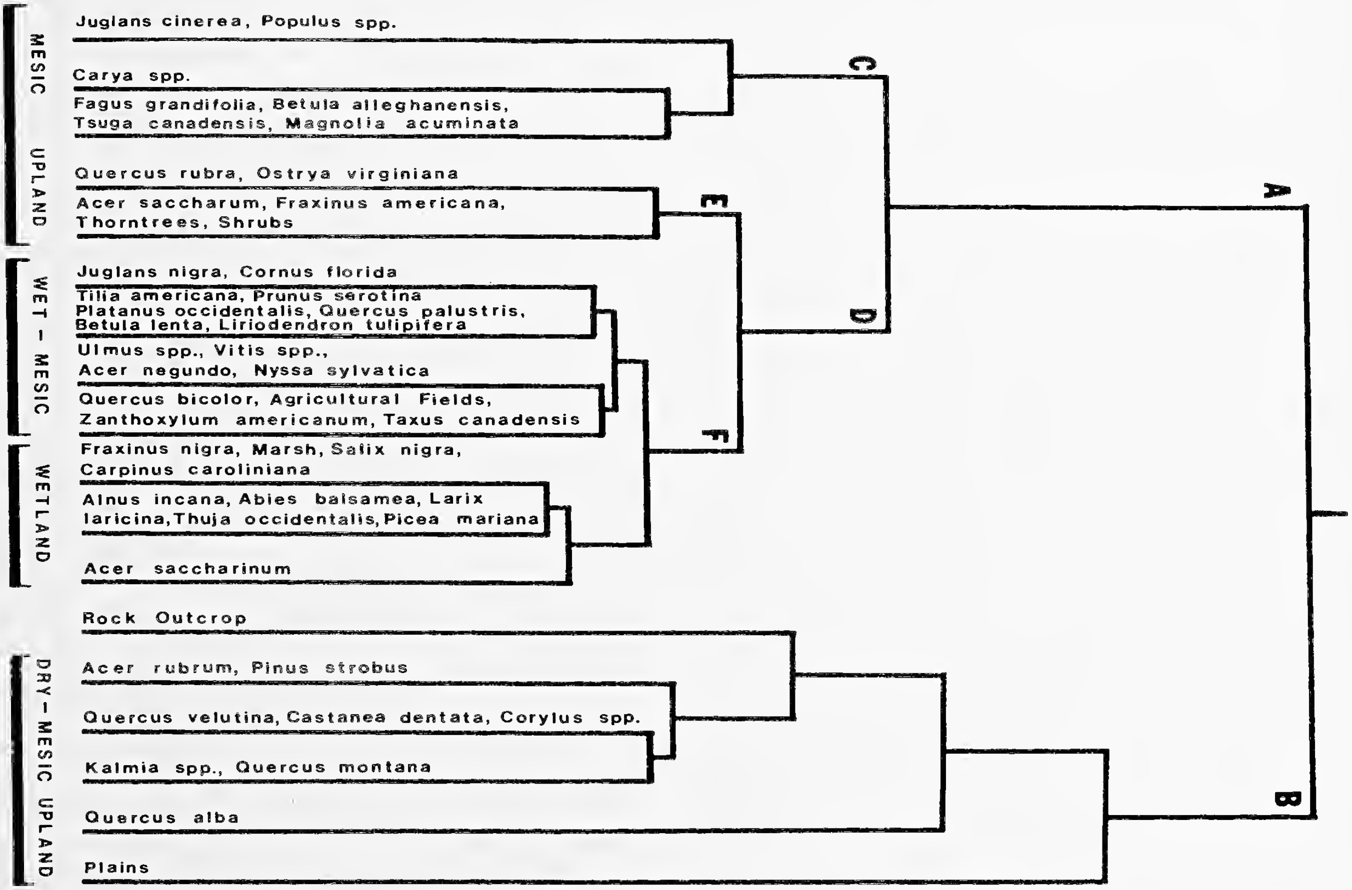


Fig. 4. Species TWINSPAN analysis. Four clusters were identified: species occurring primarily on dry-mesic uplands, wetlands, wet-mesic bottomlands, and mesic uplands. The A includes species generally found in mesic and wet-mesic communities; B includes those on dry and dry-mesic sites. C includes mesic site species associated with beech, yellow birch, and hemlock. D includes mesic site species associated with sugar maple and wet-mesic site species found with silver maple, black ash, and elm. E contains mesic site species and F the bottomland and wetland species.

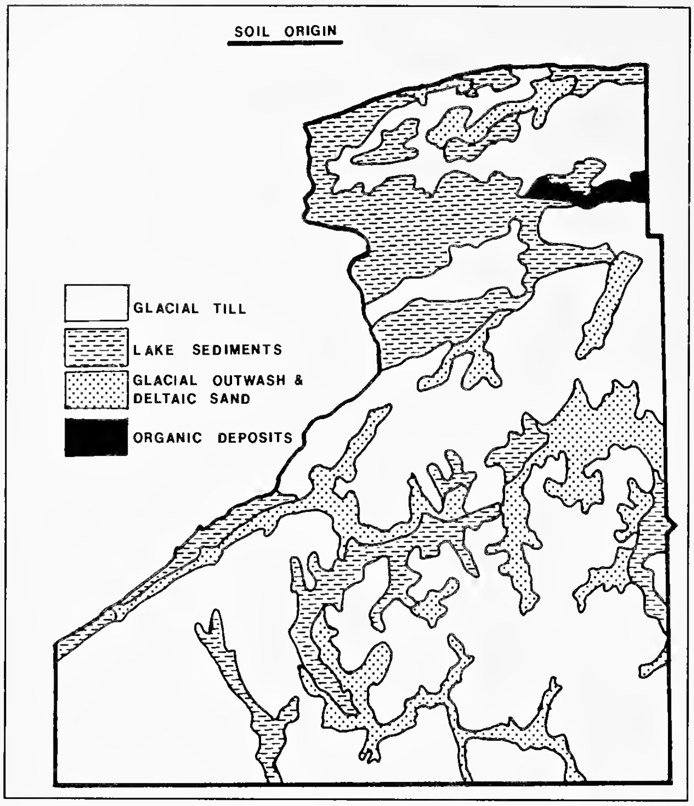


Fig. 5. A soils map indicating the origin of soils within the Holland Company Lands. Areas of glacial till, lake sediment, glacial outwash and deltaic sand, and of organic deposit origin are shown. This map is based on Cline and Marshall (1976).

ern portion of the Allegany Reservation and along Lake Erie. Sugar maple (Fig. 6.2) reached its greatest RSW on the Allegheny Plateau, particularly northeast of the Allegany Reservation and east and southeast of the Buffalo Creek Reservation. Soils in this area were described by Cline and Marshall (1977) as frigid. Basswood (Fig. 6.3), often a component of beech-sugar maple dominated forests was found most often on bottomland sites. Basswood had lower RSWs than either beech or sugar maple in most surveyed miles and was absent from many miles in the southeastern townships. This is where white pine, hemlock, and oaks dominated.

A second distributional pattern is characterized by the oaks. Black and red oak (Fig. 6.4) were distributed in the southern townships, particularly in the southeast and along the edges of the Allegany Reservation. Soils in this region were described as having cambic horizons with low base status (Dystrochrepts) (Cline and Marshall 1977). Most of these soils were described as fine loamy soils of sandstone and siltstone frost-churned residuum. These two species were also on the Lake Erie and the broader Lake Ontario Till Plain. They were notably absent from the center of the tract, northeast of the Allegany Reservation and east and southeast of the Buffalo Creek Reservation where sugar maple had its greatest RSWs.

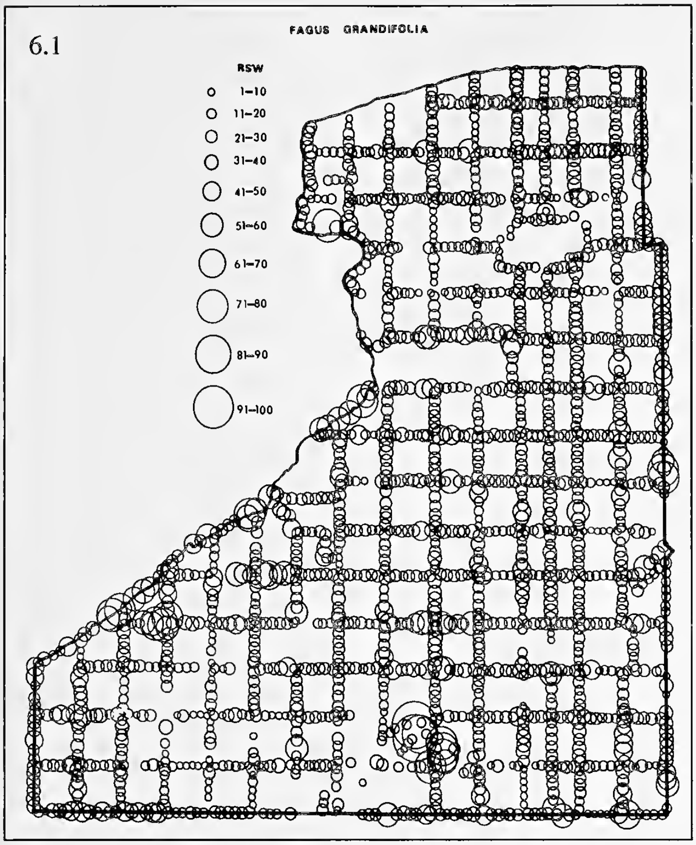
White oak (Fig. 6.5) had a distribution similar to black and red oak, occurring in the southeastern townships and on the Till Plain, particularly the Lake Ontario Plain. It was notably concentrated along the Niagara River from the Buffalo Creek Reservation to Lake Ontario. A similar concentration of white ash (Fig. 6.9) lay along the river. A white oak-white ash community still exists along the bluff overlooking the Niagara River and is visible along the Robert Moses State Parkway (personal observation). White oak was missing from the record for the central portion of the tract where sugar maple and beech dominated. Oaks weren't found to be significantly associated with soils containing a fragipan as shown by Whitney (1990) on the Allegheny Plateau nearby in Pennsylvania.

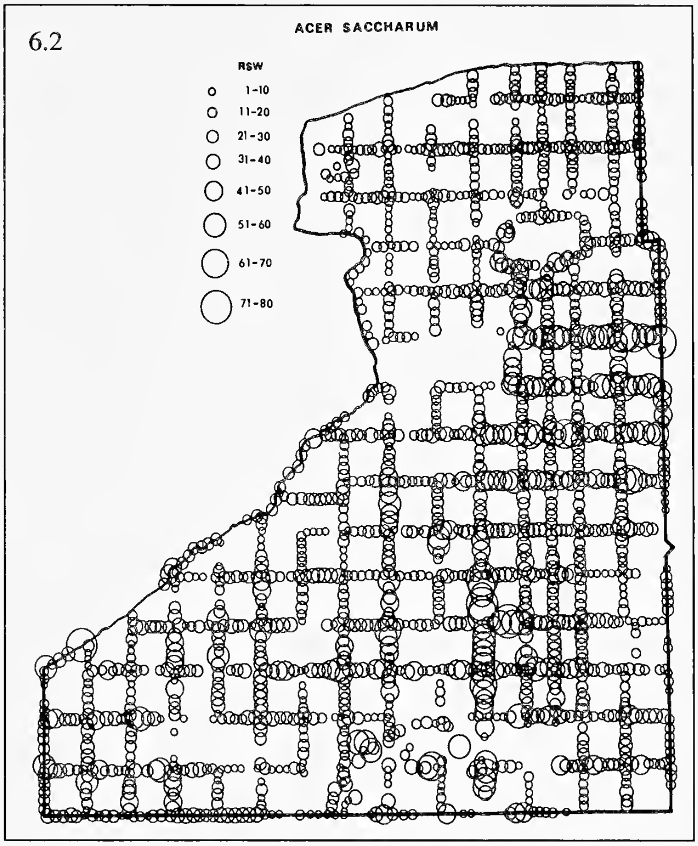
American Chestnut (*Castanea dentata*) (Fig. 6.6) was a significant component of oak-dominated forests, particularly in the southeastern townships. It reached its greatest RSW around the Allegany Reservation.

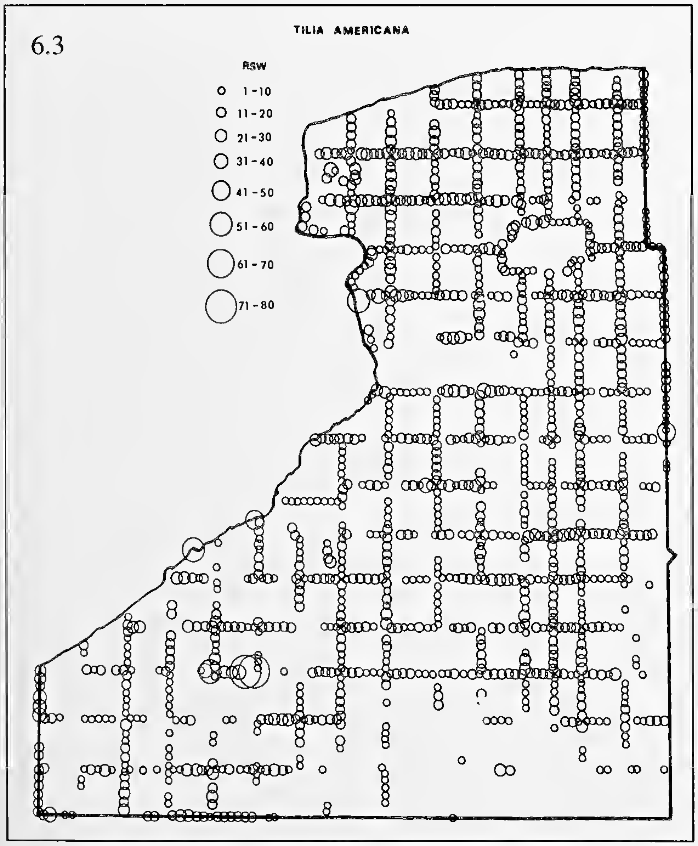
Black ash (Fig. 6.7) occurred principally in wetlands and bottomland forests and represents another pattern of distribution. The greatest concentration of communities deseribed as black ash swamp or black ash-elm-maple (presumably silver maple) was on the Lake Ontario Till Plain. A large concentration occurred in the vicinity of the Tonawanda Reservation. Distribution of this species was closely associated with that of soils developed from lake sediments (Fig. 5) as well as the histosols on the Genesee-Orleans County line. In the southern half of the tract, a concentration of black ash occurred in township 4 of ranges IX and X, an area known as Conewango Swamp (Gordon 1940), again on soils of lacustrine origin. Since many surveyor line descriptions included black ash-elm, one might expect the distribution of elm (Fig. 6.8) to be similar to black ash; however, it's quite different. Surveyors did not distinguish between *Ulmus americana*, a bottomland species, and *U. rubra*, an upland species. Consequently *Ulmus* has a wide distribution throughout the tract, although it was clearly less abundant in the southeastern townships.

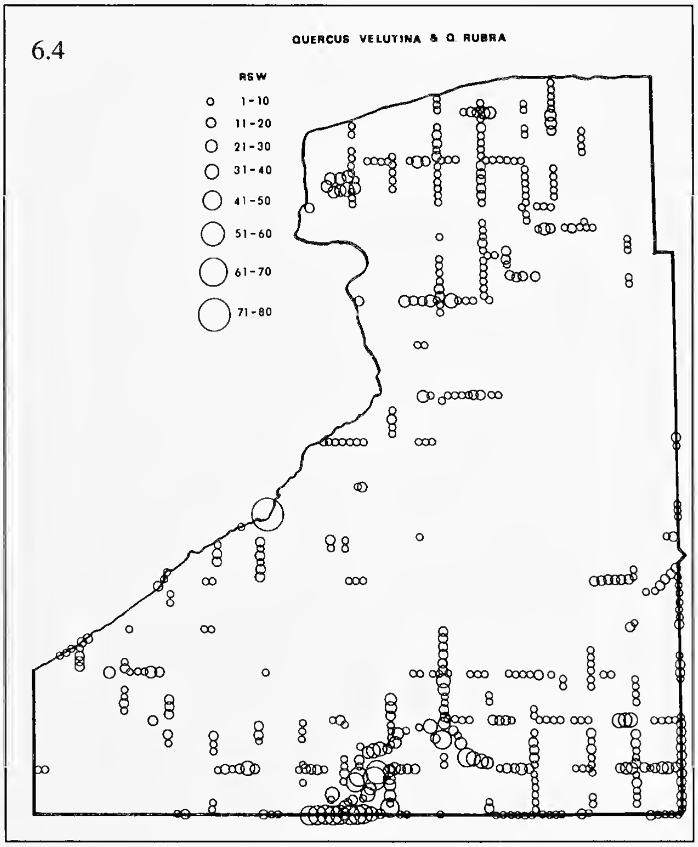
White ash was a component of beech-maple, oak, and bottomland forests (Fig. 6.9). It was absent, however, northeast of the Allegany Reservation, a pattern similar to the oaks. It was rather sparse in the southeast townships where hemlock and white pine dominated. Its greatest concentration was on the bluff overlooking the Niagara River.

The two conifers most often mentioned were hemlock (Fig. 6.10) and white pine (Fig. 6.11). Hemlock was a component of some wetlands, ravine communities, as well as upland forests (Fig. 6.10). Its largest RSWs occur along Lake Erie south of the Cattaraugus Reservation on lacustrine soils and in the vicinity of the Caneadea Reservation on the Genesee River. It was notably absent on the soils of lacustrine origin in the northwest corner of the area. White pine (Fig. 6.11) occurred in southern townships and in wetlands or bottomlands in other locations. Its greatest RSWs were in the vicinity of the Allegany Reservation where it was part of the black oak-white oak-chestnut-white pine community. At the edge of the Caneadea Reservation it was the leading dominant in the white pine-beech-hemlock-white oak community. This same community is found today in the ravines tributary to the Genesee River, particularly in Letchworth State Park. The southern townships were in a dissected landscape with a dendritic pattern of streams. Many of the slopes, particularly









Figs. 6.1-6.12. Species distribution maps along township lines. Circles represent the relative species weight (RSW) of the species in each surveyed mile in which it occurred.

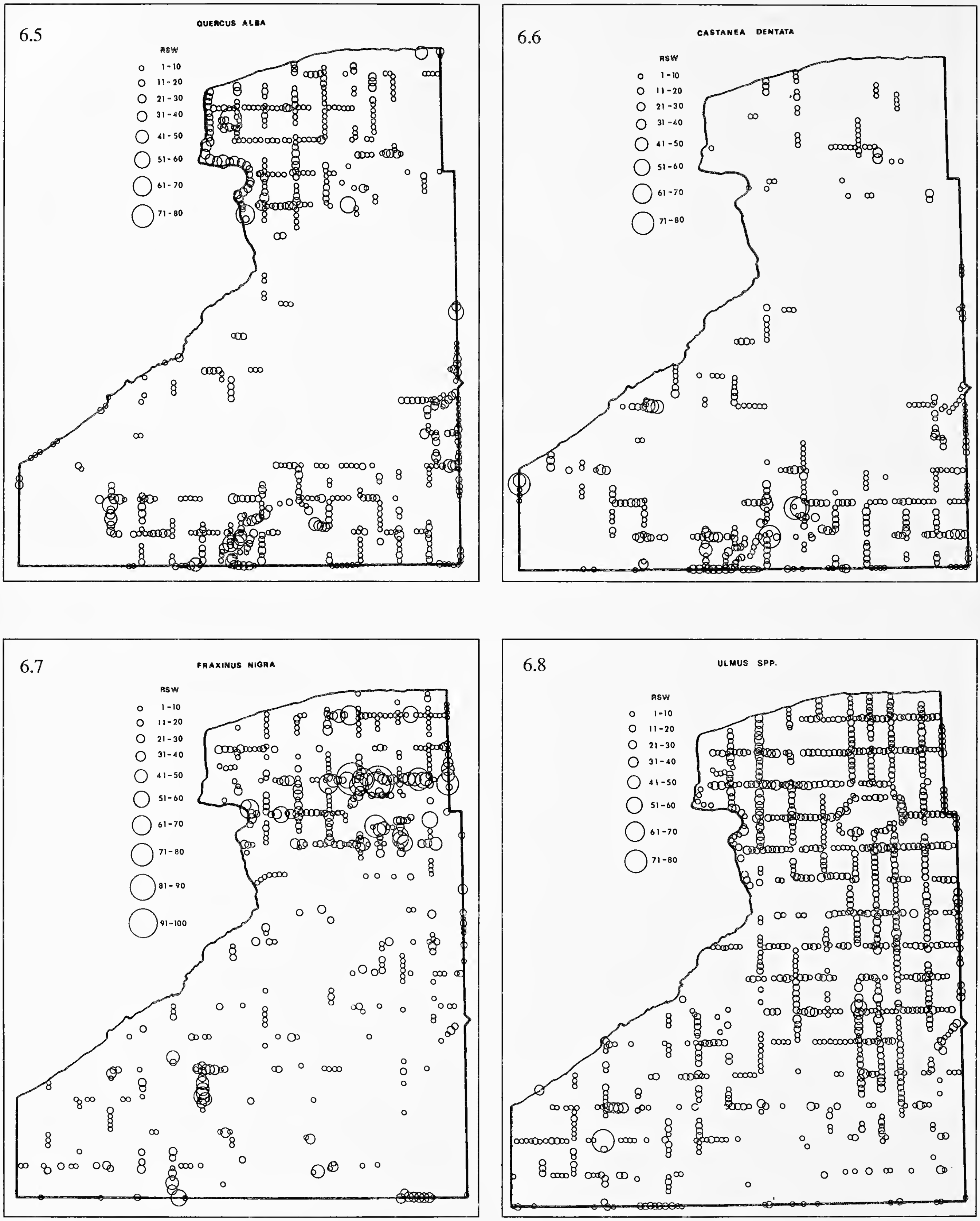
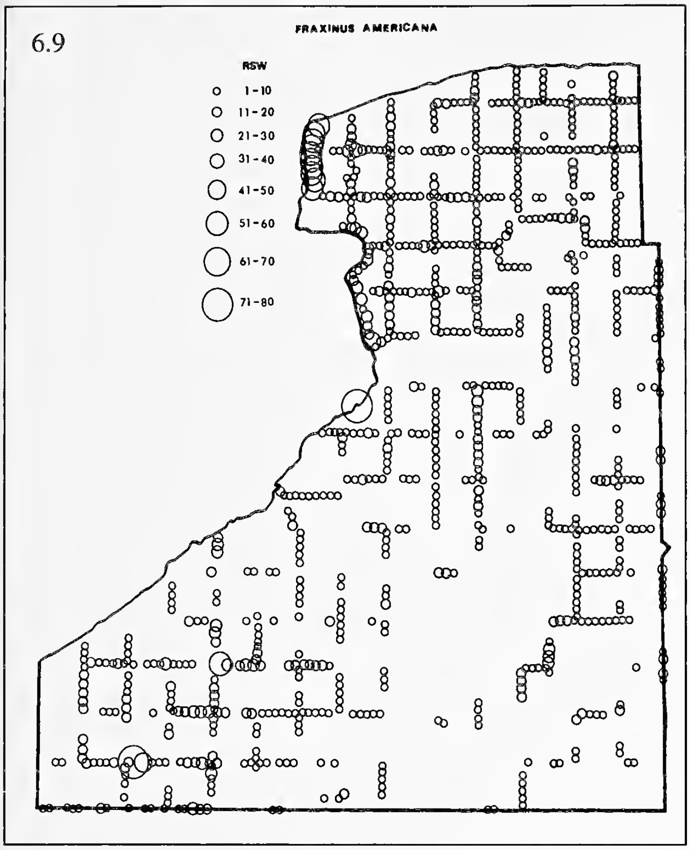
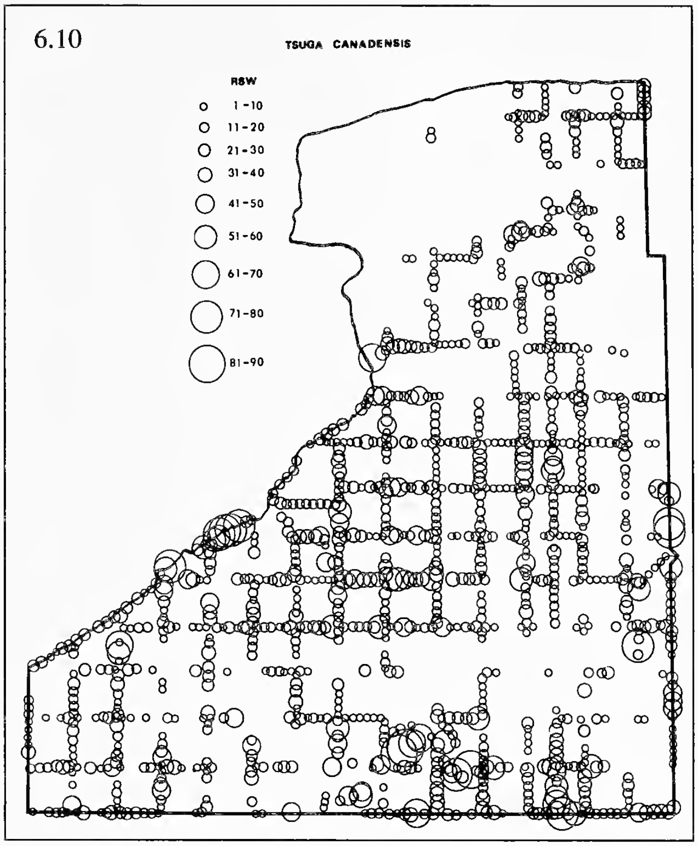
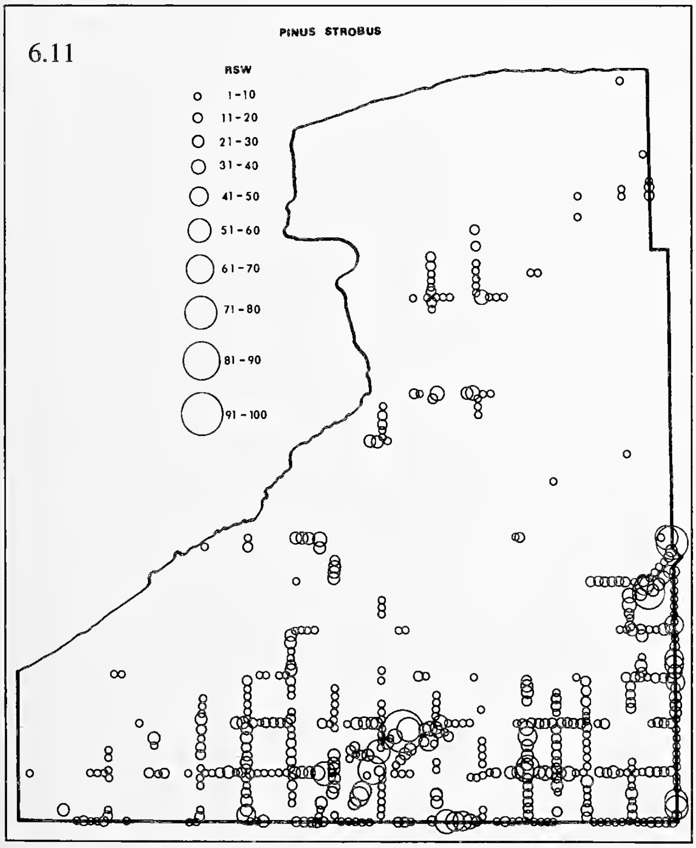


Fig. 6. (continued)







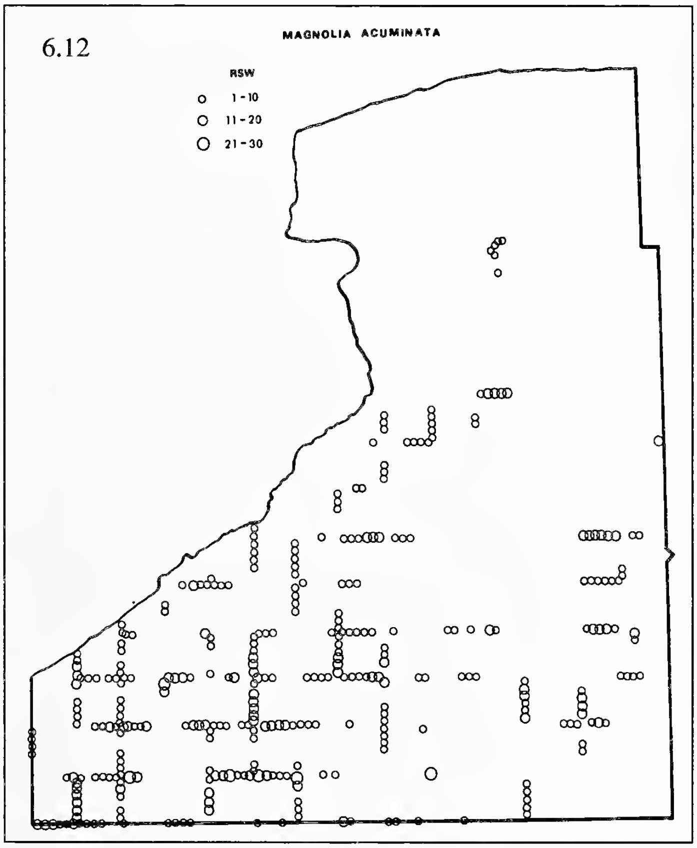


Fig. 6. (concluded).

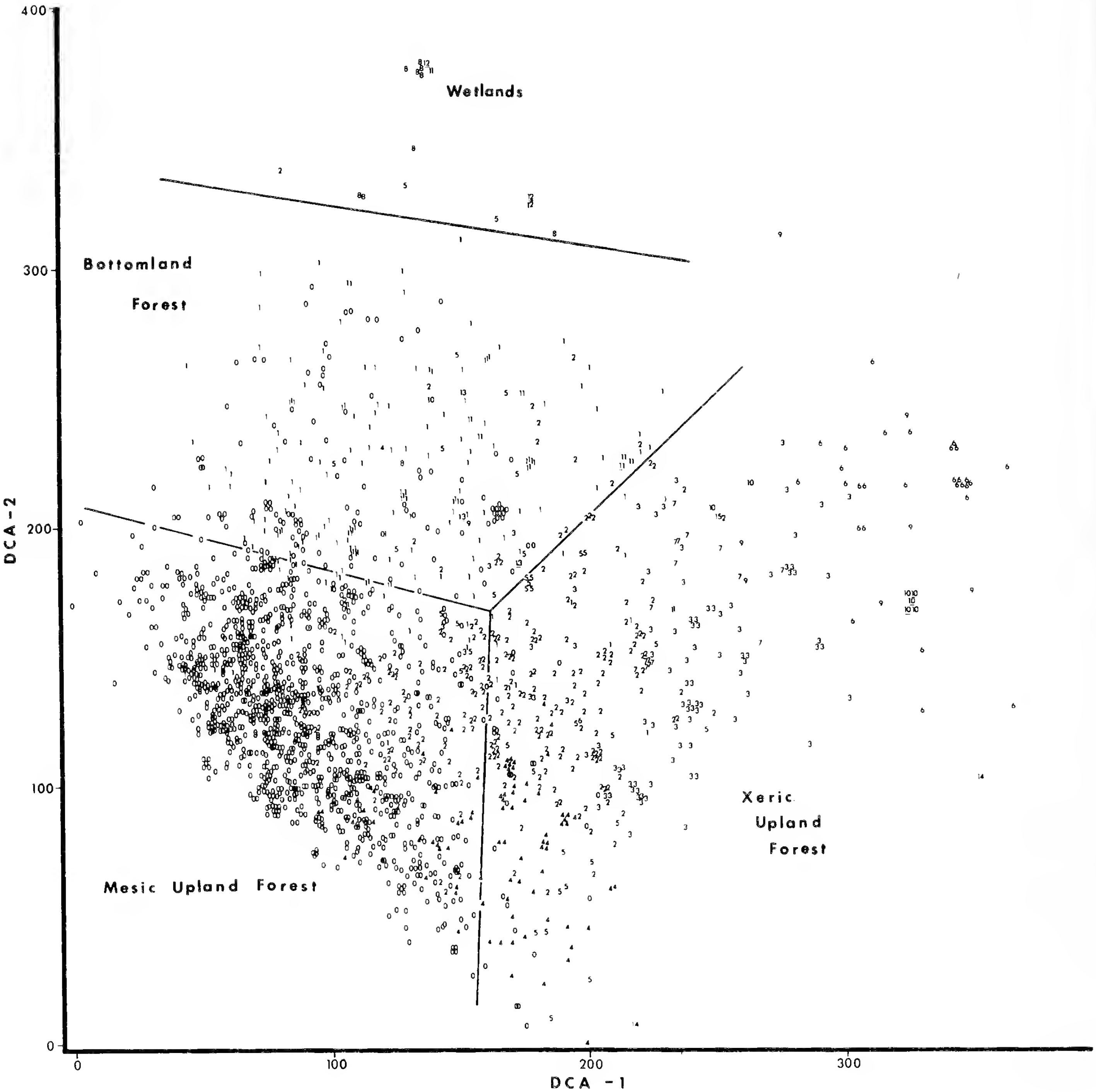


Fig. 7. Sample detrended correspondence analysis ordination with vegetation groups indicated. Numbers represent communities dominated by: 0, beech-sugar maple-basswood-butternut-cucumber tree; 1, black ash-silver maple-elm-hemlock; 2, black oak-red oak-chestnut-hemlock-white pine; 3, chestnut-red maple-cucumber tree-poplar; 4, beech-white oak-butternut; 5, hemlock-yellow birch-sugar maple; 6, chestnut-sugar maple-hickory-chestnut oak; 7, hemlock-black cherry; 8, alder-yellow birch; 9, beech-red maple-black oak; 10, white oak-sugar maple; 11, beech-alder-larch-white ash; 12, black ash; 13, black spruce; 14, chestnut oak; 15, red maple.

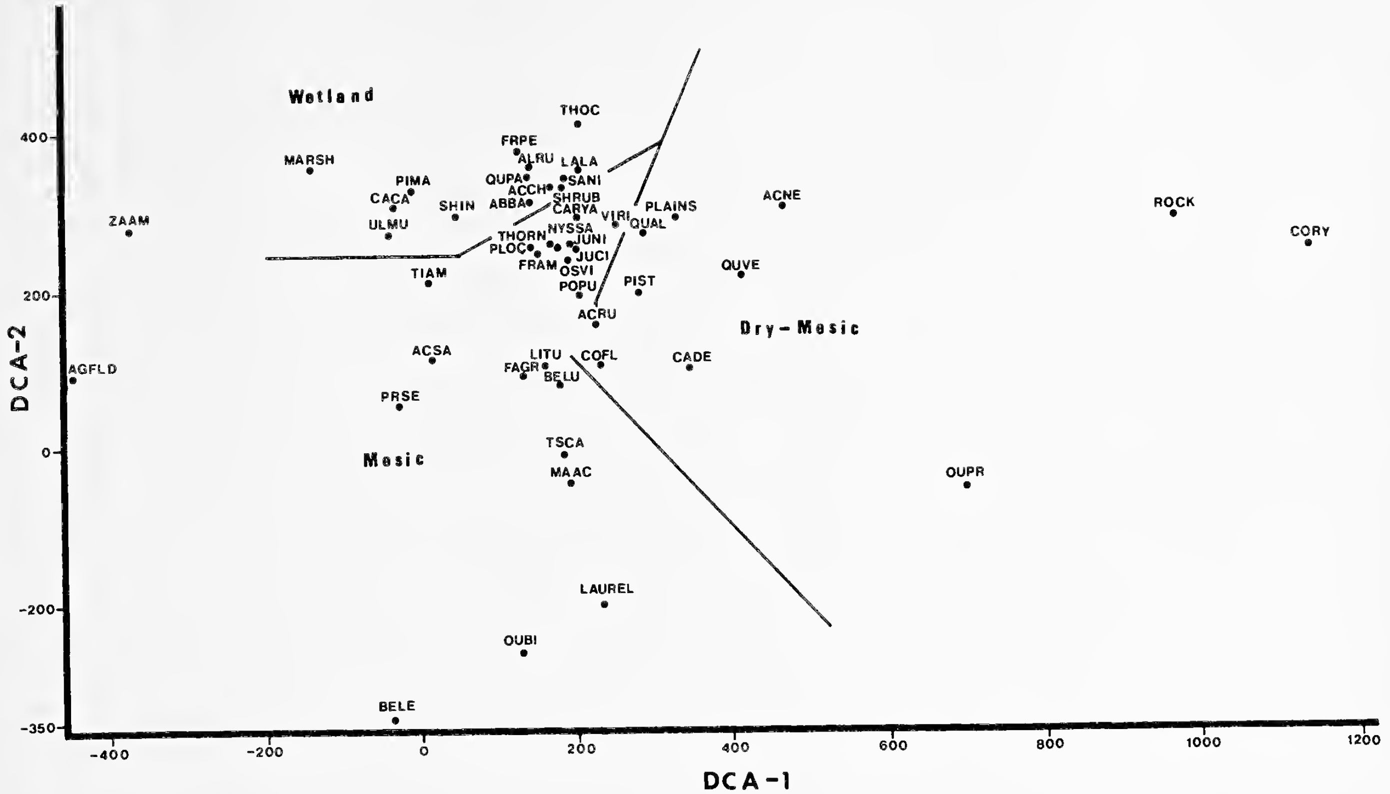


Fig. 8. Species DCA ordination. Species designations are as follows: ABBA, *Abies balsamea*; ACRU, *Acer rubrum*; ACSA, *A. saccharum*; ACCH, *A. saccharinum*; ACNE, *Acer negundo*; AGFLD, Agricultural Fields; ALRU, *Alnus incana*; BELE, *Betula lenta*; BELU, *B. alleghanensis*; CADE, *Castanea dentata*; CACA, *Carpinus caroliniana*; CARYA, *Carya* spp.; COFL, *Cornus florida*; CORY, *Corylus* spp.; FAGR, *Fagus grandifolia*; FRAM, *Fraxinus americana*; FRPE, *F. nigra*; JUCI, *Juglans cinerea*; JUNI, *J. nigra*; LALA, *Larix laricina*; LITU, *Liriodendron tulipifera*; MAAC, *Magnolia acuminata*; MARSH, marshes and mires; NYSSA, *Nyssa sylvatica*; OSVI, *Ostrya virginiana*; PIMA, *Picea mariana*; PIST, *Pinus strobus*; PLAINS, grassland; PLOC, *Platanus occidentalis*; POPU, *Populus* spp.; PRSE, *Prunus serotina*; QUAL, *Quercus alba*; QUPA, *Q. palustris*; QUBI, *Q. bicolor*; QUPR, *Q. montana*; QUVE, *Q. velutina*; LAUREL, *Kalmia* spp.; ROCK, rock outcrop; SANI, *Salix nigra*; SHIN, *Taxus canadensis*; THORN, *Crataegus* spp.; THOC, *Thuja occidentalis*; TSCA, *Tsuga canadensis*; ULMUS, *Ulmus* spp.; VIRI, *Vitis riparia*; ZAAM, *Zanthoxylum americanum*.

north facing, coves, and ravines contain white pine today (personal observation). A similar pattern of distribution occurred in these forests in the 1790s.

Cucumber tree (*Magnolia acuminata*) (Fig. 6.12) occurred primarily in the southwestern quadrant of the tract. Although this species has been associated with the mixed mesophytic forest that others (Gordon 1940, Braun 1950) described on the unglaciated section of the Allegheny Plateau (south of the Allegheny River), the species was noticeably sparse in the survey notes from this area.

Phytosociology and Environmental Gradients

The DCA ordination of samples separates wetland, bottomland, mesic upland, and xeric upland forests (Fig. 7). Wetland communities were dominated by alder, black ash or larch and are at the top of the ordination. In a lower position on the second axis are the bottomland forests of black ash-elm-silver maple. In the lower left quadrant are the mesic upland beech-sugar maple forests. In the lower right quadrant are the xeric upland forests dominated by oaks, chestnut and other species, mostly from upper slopes.

The ordination indicates a vegetational response to two interdependent environmental gradients. The first axis correlates with a topographic gradient, and the second axis correlates with a moisture gradient. Those sites at the lower left were on the lower slopes and those in the lower right were on the middle to upper slopes. Some, at the right, were also on the higher and drier flat areas above the Niagara River and at the Tuscarora Reservation.

The species DCA ordination (Fig. 8) arranged the species in a similar manner. The second axis implies a moisture gradient with wet site species (cedar, black ash, alder, larch and marshes) at the top and drier site species (white oak, chestnut, chestnut oak) further down and to the right on the first axis. Mesic species (beech, sugar maple, yellow and black birch, hemlock) are at the center and lower portion of the ordination.

Disturbance

These forests were not all in a climax state. Catastrophic disturbances had occurred and were recorded by surveyors (Seischab and Orwig 1991). Windthrow had caused the greatest amount of disturbance, 10.4 kilometers of surveyed lines having been noted as "windthrow" or "downed timber". These were all recorded from the Allegheny Plateau and comprised 0.5% of the area. Such disturbance was probably due to thunderstorms, possibly to tornadoes. A contributing factor was also trees thrown during glaze storms. Most occurrences of windthrow noted in

Table 4. Relative frequency (RF) and Relative Species Weights (RSW) on the Allegheny Plateau and Till Plain of the Holland Company Lands and the Phelps and Gorham Purchase.

	HOLLAND LAND COMPANY				PHELPS AND GORHAM PURCHASE			
	PLATEAU		TILL PLAINS		PLATEAU		TILL PLAINS	
	(RF)	(RSW)	(RF)	(RSW)	(RF)	(RSW)	(RF)	(RSW)
Fagus grandifolia	92.1	23.4	93.1	20.5	56.8	19.0	78.2	32.1
Acer saccharum	84.5	22.6	81.9	15.6	53.3	12.3	71.1	18.4
Tilia americana	61.1	7.1	84.7	10.5	25.7	3.0	59.7	12.2
Tsuga canadensis	64.5	11.4	41.9	7.3	36.1	11.1	16.9	5.0
Ulmus spp.	43.4	4.7	71.6	9.1	16.4	2.4	51.6	7.7
Fraxinus americana	33.4	2.6	69.7	6.3	21.5	3.1	49.8	8.4
Betula alleghanensis	39.2	3.7	11.7	0.8	11.0	1.3	5.1	0.5
Quercus alba	25.7	3.6	39.7	4.2	42.7	10.3	42.8	10.6
Fraxinus nigra	13.3	1.7	45.3	7.3	4.4	0.6	28.0	5.2
Pinus strobus	34.2	4.7	8.7	0.9	38.3	10.8	7.9	2.2
Quercus velutina	18.3	2.6	25.9	1.9	35.8	9.3	38.5	9.0
Castanea dentata	25.0	3.1	11.4	0.9	27.0	5.6	10.6	2.4
Carya spp.	7.6	0.6	43.0	2.9	15.6	2.6	27.8	5.2
Acer rubrum	19.4	2.1	21.4	2.5	6.3	0.7	3.7	0.6
Prunus serotina	16.5	1.1	0.3	6.4	4.3	0.3	3.2	0.2

the survey had occurred on steep slopes. Recent evidence has shown a correlation between steepness of slope and the percent of trees toppled during glaze storms (Seischab *et al, in review*).

Catastrophic windthrows are quite common in forests of the northeast. Canham and Loucks (1984) reported return times of 1000 years for windthrow in Wisconsin. Bormann and Likens (1979) indicated that large scale disturbances in the forests of the White Mountains were principally due to windthrow with "very little evidence, vegetationally or historically, that fire was widespread". Windthrow evidence has been recorded for both bottomland (Whitney 1986) and upland forests in both conifer (Lorimer 1977) and deciduous communities.

As in the forests of the White Mountains, the Holland Company survey records provided no evidence of fire as a disturbance. In the Phelps and Gorham Purchase to the east there was one record of fire in the original survey (Seischab and Orwig 1991). That record was at the edge of a pitch pine (*Pinus rigida*) stand where one might expect to find fire evidence. The second survey of that tract indicated numerous fires in the Town of Wheatland. Since the first survey reported mature forest along

Table 5. a. A comparison of forest data from New York and adjacent Pennsylvania. Data included are those from 1. the Catskill Mountains (McIntosh 1962); 2. the Military Tract (Marks and Gardescu, present volume); 3. the Phelps and Gorham Purchase (Seischab 1990); 4. the Allegheny Plateau of Pennsylvania (Whitney 1990), and 5. Pennsylvania (Lutz 1930). Both Allegheny Plateau and Till Plain data are shown. Both relative frequency (RF) data and percent of witness tree (% of trees) data are shown. b. Coefficients of similarity between the above mentioned tracts.

a.

	Catskill (% of trees) (1)	Military (RF) (2)	P&G Plat. (RF) (3)	P&G Plain (RF) (3)	HLC Plat. (RF)	HLC Plain (RF)	Penn. Plat. (% of trees) (4)	Penn. (% of trees) (5)
Beech	49.5	72.0	56.8	78.2	92.1	93.1	43.4	30.9
Hemlock	20.3	19.2	36.1	16.9	64.5	41.9	19.9	26.8
Sugar Maple	12.8	15.7	53.3	71.1	84.5	81.9	5.3	8.1
Maple & Red Maple		52.6	6.3	3.7	19.4	21.4	4.7	5.0
Basswood	1.3	47.3	25.7	59.7	61.1	84.7	0.4	0.1
Birch spp.	7.3	3.4	12.4	5.8	39.6	12.3	6.3	6.1
White Pine	0.5	9.6	38.3	7.9	34.2	8.7	3.1	6.0
Chestnut	0.5	5.5	27.0	10.6	25.0	11.4	2.8	5.6
White Oak		7.9	42.7	42.8	25.7	39.7	4.1	0.6
Red, Black & Scarlet Oak	0.3	6.5	38.0	38.7	23.5	30.0	0.6	0.2
Other Oaks		11.3	2.5	0.5	1.6	2.3	0.4	2.7

b.

	Coefficients of Similarity				
	Catskill (1)	Military	P & G	HLC	Penn. Plat.
Military Purchase (2)	42.9				
Phelps & Gorham Purchase (3)	41.1	65.0			
Holland Land Company	46.5	66.7	84.4		
Allegheny Plateau, PA (4)	79.9	51.3	44.2	50.0	
Pennsylvania (5)	51.1	47.5	55.5	60.5	54.8

the same survey line, it can be concluded that fire was used in the clearing of the forests for agricultural production.

Comparison of Forests, Circa 1749-1815

The Till Plain and Allegheny Plateau forests of the Phelps and Gorham Purchase (Seischab 1990), beginning 19 km to the east, differ somewhat from the Holland Land Company tract (Table 4). Although beech, sugar maple, basswood, and hemlock were widely distributed on the Allegheny Plateau of both tracts they were more abundant in the western tract. The Plateau of the Phelps and Gorham Purchase had greater frequencies and larger RSWs of white oak, black oak, and white pine with a larger oak-pine component. The Till Plains of the Holland tract had higher frequencies of beech, sugar maple, basswood, hemlock, elm, ash, and yellow birch. The Till Plain of the Phelps and Gorham had more white and black oak, which occurred on sandy outwash areas in Monroe County, in the northwest portion of the Phelps and Gorham Purchase.

The forests on the Till Plain of the Holland Land Company contained less hemlock and more basswood than did the Allegheny Plateau. The Allegheny Plateau portion of the Holland Land Company is similar to those originally surveyed in the Catskill Mountains to the east (McIntosh 1962) which was also dominated by beech, hemlock and sugar maple (Table 5a), however, basswood was not a dominant species in the Catskills. South of the Holland Company Lands, on the Allegheny Plateau in Pennsylvania, the forests were again dominated by beech, hemlock, and sugar maple (Lutz 1930, Whitney 1990), again lacking in significant amounts of basswood. These Pennsylvania forests and those of the Catskills were very similar, being dominated by beech, hemlock, sugar maple, and birch, and containing very little basswood. Basswood was more characteristic in central and western New York forests where it had a relative frequency between 25.7% and 84.7% (Table 5a).

In the Military Tract (Marks and Gardescu, present volume) the top-ranking bounds taxa on the Plateau were beech, maple, and basswood followed by oaks (including white), whereas on the Lowland they were beech, maple, basswood, then hemlock. Thus the Military Tract seems to have been more similar to the forests of western New York than those of adjacent Pennsylvania.

The similarity coefficients indicate that the vegetation of the Holland Company was most similar to that of the Phelps and Gorham purchase (84.4%) immediately to the east (Table 5b). It was 66.7% similar to the vegetation of the Military Purchase and only 50-60% similar to the forests in Pennsylvania to the immediate south. The forest of the Allegheny Plateau in Pennsylvania (Whitney 1990) were most similar to those of the Catskill Mountains (McIntosh 1962) (79.9%) rather than to those of the Holland Company Lands to their immediate north.

Discussion

Gordon (1940) examined the primeval forests of Cattaraugus County (one of the eight counties included in the present study), on the Pennsylvania border of the Holland Company Lands, using bearing trees identified in the survey notes to identify "edaphic climax associations" as described by Weaver and Clements (1929) and later used by Braun (1950). He identified six associations: Oak-Chestnut Forest on dry ridges, south and southwest facing slopes, Mixed Mesophytic Forest on middle to upper slopes, the Beech-Sugar Maple Forest lacking hemlock and birch on the better drained soils near ridge tops, Bottomland Hardwood Forests along the major tributaries, White Pine-American Elm Swamp Forest on "river flats" and floodplains, and Black Spruce-Tamarack Bog Forest on organic soils in depressions of glacial origin.

In a general way, these association names can be used in the classification of forests in the rest of the Holland Company Lands, recognizing that community demarcations were usually not clearly defined.

The occurrence of beech-maple, oak-chestnut, oak-hickory, and bottomland forests in the Holland Company Lands are, generally, as described by Gordon (1940). Those forests which he described as White Pine-American Elm Forest were more often described by surveyors as a combination of black ash, elm, and silver maple forests in most of these western counties. White pine was more often a component of bottomland or wetland forests which included hemlock and, at times, northern white cedar. These conifer swamps occurred less frequently than did the black ash-elm-silver maple forests.

Braun (1950) recognized two forest types in western New York: Beech-Maple forests on the Till Plain north and west of the Allegheny Plateau, and Hemlock-White Pine-Northern Hardwoods forest on the Allegheny Plateau. The beech-maple communities in this study lay primarily on the Lake Plains in agreement with Braun (1950). They also included ash-silver maple-elm swamp forests, particularly in Niagara and Orleans Counties adjacent to Lake Ontario. The beech-sugar maple forests on the Allegheny Plateau were part of the Hemlock-White Pine-Northern Hardwoods Region with hemlock occurring in ravines such as those described by Lewin (1974) for the Finger Lakes area. Hemlock also occurred in the southern tier of counties in the Holland Company Lands. Allegany, Cattaraugus, and Chautauqua Counties, adjacent to Pennsylvania, have extensive areas with dendritic drainage patterns, steep slopes, and steep stream channels. Hemlock and white pine were widely distributed in this area, occurring in coves, ravines, and wetland forests, as well as being a component of the surrounding upland forests.

Gordon (1940) described mixed-mesophytic forest from the unglaciated section of western New York, south of the Allegheny River as occurring between hemlock-beech or beech-sugar maple on lower slopes and oak-chestnut on upper slopes. Similarly, Braun (1950) described such forests occurring at "an intermediate position on slopes between the beech-maple below and the oak-chestnut above." Mixed-mesophytic forest implies a great diversity of oaks and such characteristic species as *Magnolia acuminata*, *Nyssa sylvatica*, and *Liriodendron tulipifera*, as well as the dominants *Fagus grandifolia*, *Acer saccharum*, *Tsuga canadensis*, and *Acer rubrum*.

Data from the forests of the 1790s do not demonstrate a great

diversity of oaks in the unglaciated section of western New York, nor an extensive presence of *Magnolia*, *Nyssa*, or *Liriodendron*. The average number of species recorded/mile surveyed for the Holland Company Lands was 6.75. That for the unglaciated section was 5.42 species/mile, indicating a somewhat lower species diversity for the unglaciated section. The survey data do support Gordon's contention of the widespread existence of this community south of the Allegheny River. In a separate TWINSPAN classification of the unglaciated region, beech-sugar maple, hemlock-birch, white pine-red maple, basswood-magnolia-butternut, black oak-chestnut, white ash-white oak-hickory, and wetland forests of black ash-elm or black spruce communities were identified. Even though *Magnolia* was identified as a component of one of these communities, it was more widely distributed to the west of this region than on the unglaciated section. The survey notes do not provide evidence of mixed mesophytic forest in the area.

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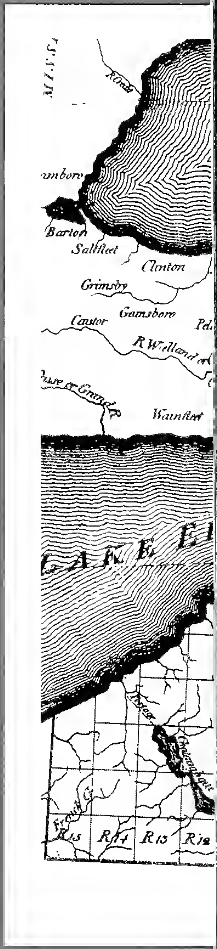

Cover: Portion of a map of the State of New York by Simeon DeWitt, Surveyor General (Albany, 1804). The Holland Land Company lands and the Military Tract are highlighted. (Courtesy of the New York State Library, Manuscripts and Special Collections Division).

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Richard S. Mitchell, Editor

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PREFACE

OUR GOAL in producing this series is to present a useful and authoritative account of the plants of New York State. These contributions are intended to reflect the knowledge and taxonomic opinions of specialists who prepare the manuscripts while following a generalized format for consistency. Inclusion of ecological, distributional, medical and economic information on each species is also one of our major aims. Habitat references, flowering times, pertinent synonymy, etc., often apply specifically to New York plants rather than to the entire species. Complete illustration should facilitate identification of specimens for those who are not formally trained in botany. Descriptions are original, ordered and as complete as possible to provide sequential cross-referencing.

Distribution maps accompany species of seed plants, ferns, mosses, algae, lichens and some groups of fungi. These are plotted by counties to eliminate pinpointing endangered habitats, while offering an accurate visual picture of past collecting. Maps are based on the master file at the New York State Museum, Albany, supplemented by available data (specimens examined by the authors) from herbaria housing significant New York collections. Data or literature citations for any map may be obtained, on approval, from the State Museum. We hope that these bulletins will serve individuals with interest in the flora, as well as to provide information for state and Federal agencies, conservation organizations, industry and the scientific community. With these works go our hopes for the preservation and wise use of a precious and life-giving resource — our State's plant life.

The New York State Flora Committee

The steering council of the New York State Flora Committee met for the first time on January 19, 1976, and established as its goals the promotion of study of the State's plant resources and the publication of this series of museum bulletins. These contributions will be continually updated after publication for possible incorporation into larger volumes at a later date.

Members of the council at the time of this publication are:

Richard S. Mitchell, Chairman, State Botanist, N. Y. State Museum, Albany (Vascular Plants)
Charles J. Sheviak, Curator of Botany, N. Y. State Museum, Albany (Vascular Plants)
Norton G. Miller, N. Y. State Biological Survey, Albany (Bryophytes)
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George J. Schumacher, Biology Dept. SUNY, Binghamton (Algae)
Gordon C. Tucker, N. Y. State Museum, Albany (Vascular Plants)

CONTENTS

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IMPORTANT NOTE

All economic uses, folklore, medical and pharmaceutical notes, uses as foodstuffs, etc., are compiled from the literature and do not represent an endorsement by the authors or the New York State Museum. Some of the uses may, indeed, be dangerous if incorrectly employed. Some are not effective and are presented for historical interest only.

LEGEND

FOR ALL MAPS IN THE FOLLOWING PUBLICATION THE FOLLOWING SYMBOLS APPLY

Solid dot—-specimen seen by author: data on file at the State Herbarium (NYS)

Circle—-field observation or literature citation with location data and observer's or author's name on file (NYS)

FOR ALL ILLUSTRATIONS IN THIS PUBLICATION, THE FOLLOWING LETTER-DESIGNATIONS APPLY:

A. Habit sketch
B. Root
C. Leaf
D. Inflorescence(s)
E. Inflorescence node
F. Bracteoles
G. Flower
H. Fruiting calyx
I. Fruit
J. Seed

Chenopodiaceae (Goosefoot Family)

The Chenopodiaceae: a family of about 100 genera and 1,500 species of herbs and shrubs worldwide. The group is cosmopolitan in distribution and particularly diverse in arid areas. A number of species are halophytic, and many are weeds within and outside of their natural ranges. Goosefoot (*Chenopodium album* L.), one of the more widespread and common weeds of the world, has followed in the footsteps of man since prehistory, and is sometimes used as a pot herb. Quinoa (*Chenopodium quinoa* Willd.), is a pseudo-cereal staple food in the Andes, and the fruits of some other species of the genus have been eaten, occasionally. Spinach (*Spinacia*) is widely used as a salad green and pot herb. Beet (*Beta*) is used as a pot herb (Swiss chard); the roots are eaten as a vegetable (garden beet), and it may serve as a source of sucrose and glucose (sugar beet). Several genera (particularly *Salsola*, *Salicornia* and *Suaeda*) have been used as sources of soda for the production of soap and glass. Pollen grains of the Chenopodiaceae (and many Amaranthaceae) are unusual in being spherical with numerous surface pores (sometimes called "golf-ball pollen"). Many species of both families are known for the aeroallergenic nature of their pollen. Historically, pollen of the Chenopod/Amaranth type has been found in Maestrichian deposits, representing the oldest fossil records of Caryophyllidae. In addition to their pollen, many genera of Chenopodiaceae share other morphological similarities with those of Amaranthaceae, thus, confounding a clear distinction between the families.

The chenopods have been classified in several ways. One recent study (Scott, 1977a) suggested that they be split into three families: Chenopodiaceae, Salsolaceae and Salicorniaceae. Although habit and embryo shape have been used for decades as characters to distinguish these subgroups, these characters are considered by most taxonomists insufficient to warrant the recognition of separate families.

FAMILY DESCRIPTION

A family of annual and perennial herbs and shrubs (rarely trees), sometimes with fleshy, nearly leafless stems. The leaves are alternate (rarely opposite), simple, entire, toothed or lobed, often somewhat succulent, ranging from papery and flat to very fleshy and terete. Leaves are sometimes reduced to sheaths at the nodes, and stipules are lacking. The inflorescences are usually composed of glomerules (congested cymes in the leaf axils), or the glomerules are often borne in compound spikes, panicles or cymes. Occasionally, the inflorescence is not glomerulose, but a simple panicle or spike. Each flower is subtended by a bract and two bracteoles (or the bract, bracteoles or both may be absent). Flowers are small, usually regular, perfect or less often unisexual, the plants then monoecious or dioecious. There are (1-) 5 (-6) sepals, or sometimes the sepals are absent in staminate flowers. The sepals are distinct or connate (usually only at the base), usually herbaceous or membranaceous, rarely scarious. Stamens are commonly the same number as the tepals and opposite them, their filaments free or connate at the base, inserted on a disc on the calyx or hypogynous. The anthers are tetrasporangiate and dithecal. The ovary is usually superior (semi-inferior in *Beta*), 1-locular, 2-3 (-5) carpellate, the ovules solitary, basal, amphitropous or usually campylotropous, bitegmic, crassinucellar. Styles are 1-3, distinct or more or less connate; stigmas are mostly 2-3, dry. The fruit is a utricle or nutlet, usually indehiscent, seldom with irregular or circumscissile dehiscence, often subtended by the persistent calyx or by persistent bracteoles. Sometimes, several fruits are aggregated by connation of the somewhat fleshy tepals. The seeds are mostly lenticular, each with an annular, spirally twisted or only slightly curved peripheral embryo, surrounding the usually abundant, starchy, hard perisperm. True endosperm is vestigial or absent.

KEY TO GENERA

1. Leaves reduced to a sheath surrounding the stem, with 2 appressed, opposite scales at the apex; flowers in threes, sunken into the jointed, succulent stem .... 1. *Salicornia*
1. Leaves not reduced to a sheath; flowers not sunken into a jointed, fleshy stem .... (2)
  2. Bracteoles enlarged and accrescent in fruit; flowers unisexual .... (3)
  2. Bracteoles not enlarged or accrescent in fruit; flowers perfect (except in *Axyris* where they are unisexual) .... (4)
3. Bracteoles free, at least at their apex; stigmas 2-3 .... 2. *Atriplex*
3. Bracteoles fused up to the apex; stigmas 4-5 .... 3. *Spinacia*
  4. Fruit dehiscent; ovary semi-inferior; roots often enlarged .... 4. *Beta*
  4. Fruit indehiscent; ovary superior; roots not notably enlarged .... (5)
5. Leaves filiform to linear, linear-lanceolate, or linear- oblong, entire; sessile .... (6)
5. Leaves lanceolate to ovate, entire, toothed, or lobed; petioled (or the upper leaves sessile) .... (11)

6. Leaves spine-tipped, the principal ones filiform; seed orbicular or ovoid, not lenticular; embryo spiralled ....5. *Salsola*
6. Leaves not spine-tipped, at most subulate-pointed; seeds lenticular; embryo ring-shaped, horseshoe-shaped or coiled.(7)
7. Leaves thick and somewhat fleshy, terete or plano-convex in cross-section; embryo coiled; flowers commonly 3 in the axils of leaves ....6. *Suaeda*
7. Leaves scarcely fleshy, flat, at least toward the base; embryo ring-shaped; flowers borne variously ....(8)
8. Calyx forming lateral (horizontal) wings or spines in fruit; leaves pubescent ....7. *Bassia*
8. Calyx without lateral spines in fruit, lacking a margin or with vertical, winged keels; leaves variously pubescent or glabrous ....(9)
9. Flowers with 1 sepal; fruit usually with a vertical winged margin ....8. *Corispermum*
9. Flowers with 3-5 sepals or sepal lobes; fruit without a margin ....(10)
10. Sepals fused at the base, not imbricate ....13. *Chenopodium*
10. Sepals imbricate ....9. *Polycnemum*
11. Leaves and stems stellate-pubescent; flowers unisexual ....10. *Axyris*
11. Leaves variously pubescent or glabrous, but not stellate pubescent; flowers perfect or occasionally pistillate ....(12)
12. Fruiting calyx with a broad, lateral wing; inflorescence a diffuse panicle ....11. *Cycloloma*
12. Fruiting calyx wingless or nearly so, sometimes with a vertical, winged keel; inflorescence often consisting of clustered glomerules ....(13)
13. Sepal 1 per flower ....12. *Monolepis*
13. Sepals 5 per flower ....13. *Chenopodium*

1. SALICORNIA

Common Names: Glasswort, Saltwort

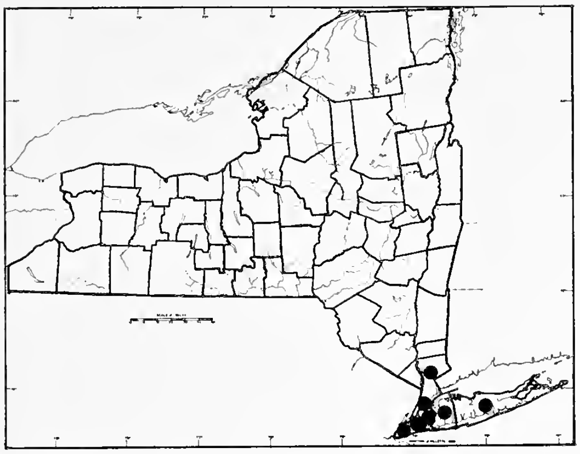
Authority: Linnaeus, Species Pl. I, p. 3, 1753

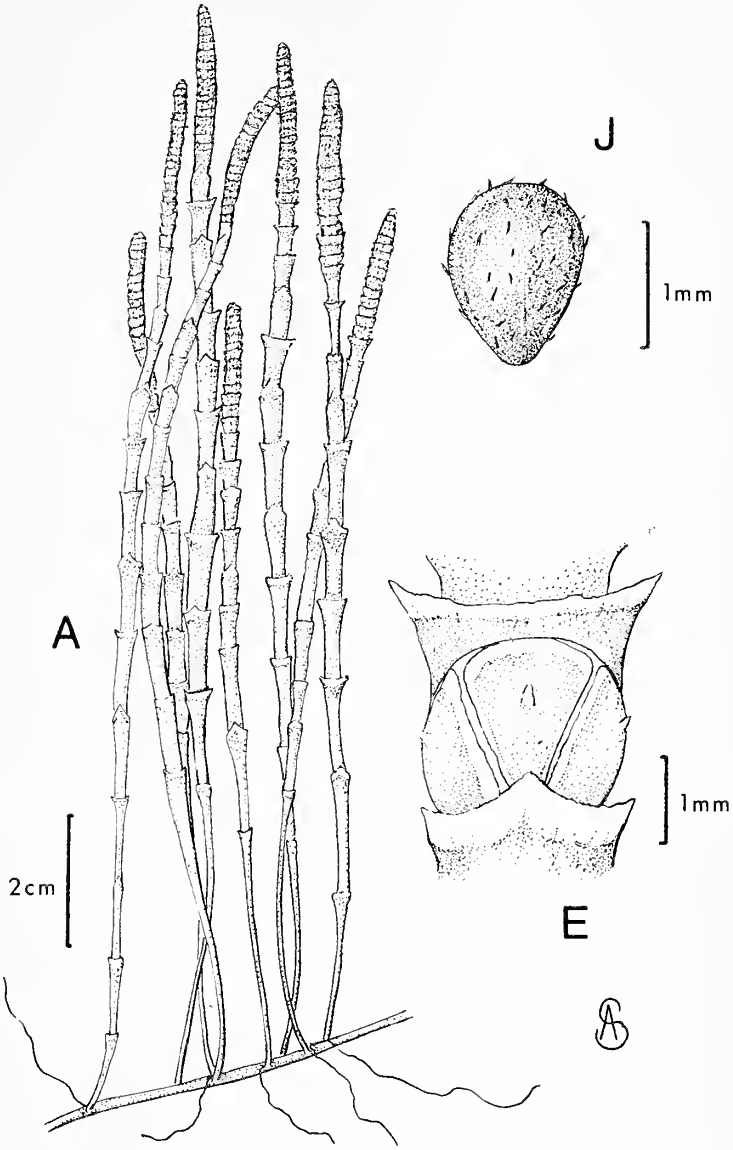
A genus of as few as 13, or up to 35 species, depending upon taxonomic interpretation. In the broad sense of the group, adopted here, the genus is cosmopolitan along sea coasts and in other brackish habitats. The glassworts and saltworts are easily recognized by their jointed, fleshy stems, opposite scales, and fleshy spikes. Scott (1977a) split the genus, segregating (as *Sarcocornia*), members differing in their perennial habit and inflorescence structure. While these characters are sufficient for subgeneric delimitation, the segregation of genera within this easily recognized group seems to serve little purpose, and is not followed here. Three species of *Salicornia* occur within our range, and a fourth, *S. rubra* L., is widely scattered in central North America. *Salicornia* plants were once burned and their ashes used as a source of soda in the production of soap and glass, hence the name glasswort. Sometimes known as samphire greens, they have also been used as food.

Description: Plants with **bisexual** or **pistillate** flowers (when polygamomonoecious); **stigmas** 2, subulate; **style** 1, lacerate above or ending in stigmas; **ovary** 1, superior, ovoid, unilocular with a single, basal **ovule**; **fruit** an indehiscent utricle sunken into the fleshy spike and surrounded by the perianth, the pericarp membranaceous, non-adherent, closely investing the seed and nearly the same size; **seed** 1, vertical, homomorphic, minutely hairy; **embryo** conduplicate; **perisperm** none; **radicle** inferior; **stamens** 1-2, hypogynous; **filaments** membranaceous, linear; **anthers** tetrasporangiate; **calyx** obpyramidal, usually truncate at the summit and 3-4 lobed, fleshy or herbaceous, spongy in fruit, opening by a small terminal slit only; **bracts** scale-like, sometimes fused and forming a shallow cup; the **flowers** in groups of three, sessile and sunken into the fleshy rachis; **inflorescence** terminal, in cylindrical spikes; **leaves** reduced and fused into a fleshy sheath surrounding the stem, with minute, opposite, scarcely projecting scales at the point of attachment; **stems** succulent, herbaceous or sometimes slightly woody, erect or sprawling, branched; **annuals** or **perennials** with a taproot or horizontal rhizome.

KEY TO SPECIES

1. Plants annual from a taproot; the central flower of each cluster longer than the 2 lateral ones ....(2)
1. Plants perennial from a horizontal rhizome; central flower of the cluster not noticeably prominent ....1. *S. perennis*
2. Scales acute to acuminate, mucronate; spike inflated, wider than the stem ....2. *S. bigelovii*
2. Scales acute to rounded, not mucronate; spike usually not wider than the stem ....3. *S. europaea*





1. *Salicornia perennis* Miller

Common Names: Saltwort, Glasswort, Samphire, Leadgrass

Type Description: Miller, Gard. Dict. ed. 8, *Salicornia* no. 2, 1768

Synonyms: *Arthrocnemum perenne* (Miller) Moss, *Salicornia virginica* of authors, not L., *Sarcocornia perennis* (Miller) A. J. Scott

Origin: Native to the Atlantic Coasts of Europe and North America

Habitats: Sea beaches and salt marshes

Habit: Prostrate, succulent subshrub with ascending to erect branch tips

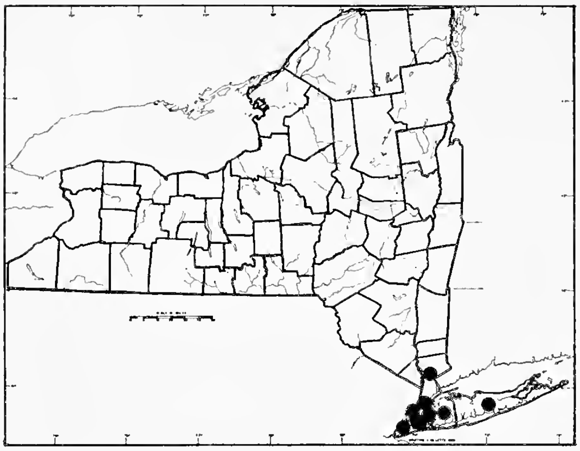
Flowering: July-September

Fruiting: September-November

General Distribution: Europe, Africa and North America; in North America: along the Atlantic Coast from southern New Hampshire to South Carolina

Description: Plants with **bisexual** flowers; **stigmas** spreading, 0.3-0.6 mm long; **style** 0.4-0.8 mm long; **fruit** oblong or ellipsoid; **seed** greenish-brown to gray, oblong or ellipsoid, 1.2-1.4 mm long, 0.6-0.8 mm broad, testa covered with slender curved hairs; **stamens** 2; **filaments** 0.3-0.5 mm, usually not visible from outside the flower; **anthers** obovoid, yellowish, 0.6-0.8 mm long; **calyx** fleshy, 3-4-lobed, 0.8-1.0 mm long, central and lateral flowers 1.2-1.5 mm tall, 0.8-1.1 mm broad, subequal or usually the central larger than the lateral, the central flower cuneate-obovate, truncate across the top, extending over half way to the top of the joint, lateral flowers obliquely ovate; **inflorescence** erect, cylindrical spikes, 15-50 cm long, the individual joints 1.8-2.8 mm long, 2.0-2.2 mm broad; **inflorescence scales** broadly deltate or forming a shallow cup, 1.1-1.5 mm long, 2.5-2.7 mm broad, apex acuminate; **stems** hard and woody (at least the lower portion), prostrate, rooting, forming mats 1 meter or less in diameter, with erect or ascending non-flowering and flowering stems fleshy, 1-3 dm tall, joints 6-20 mm long, 1-3 mm broad, scales rounded to acute, from a **perennial** rhizome with fibrous, adventitious **roots** (2n = 18).

Nomenclatural Note: This species has often been treated under the Linnaean name *Salicornia virginica* L. but Ball (pers. comm.) has checked the type of *S. virginica* and found it to be annual, therefore rendering this binomial invalid for this plant. The North American plants may not be conspecific with European *S. perennis*, but, until comparisons of living materials of the American and European plants have been made, I am retaining American populations under the name *S. perennis*.



2. *Salicornia bigelovii* Torr.

Common Names: Saltwort, Glasswort, Samphire

Type Description: Torrey, Bot. Mex. Bound. Surv. p. 184, 1859

Origin: Native to northern North America, particularly along the coasts

Habitats: Tidal marshes, shores and swales, inland salt lake shores and alkaline flats

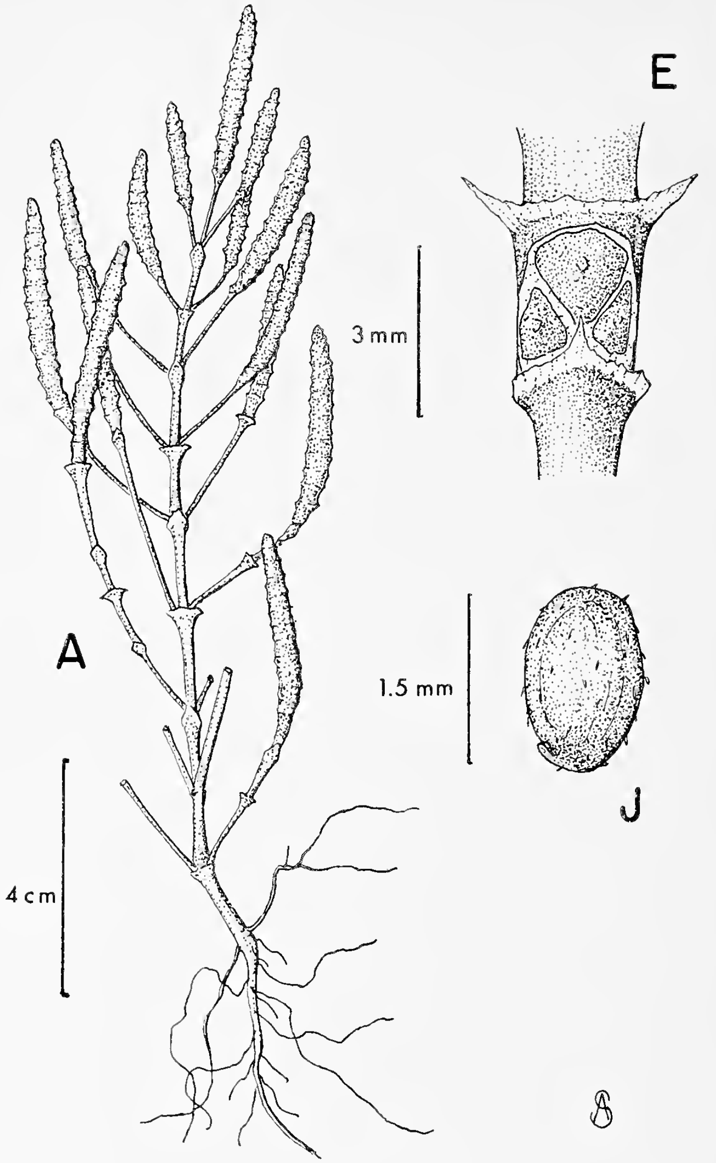
Habit: Simple-stemmed or branched, succulent annual herbs

Flowering: July-September

Fruiting: August-November

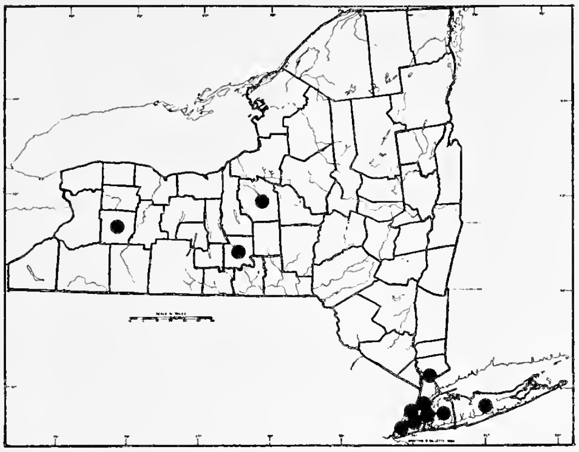
General Distribution: Atlantic coast from southern Maine to South Carolina, west to Utah and the Pacific coast, from northern British Columbia south to Baja California

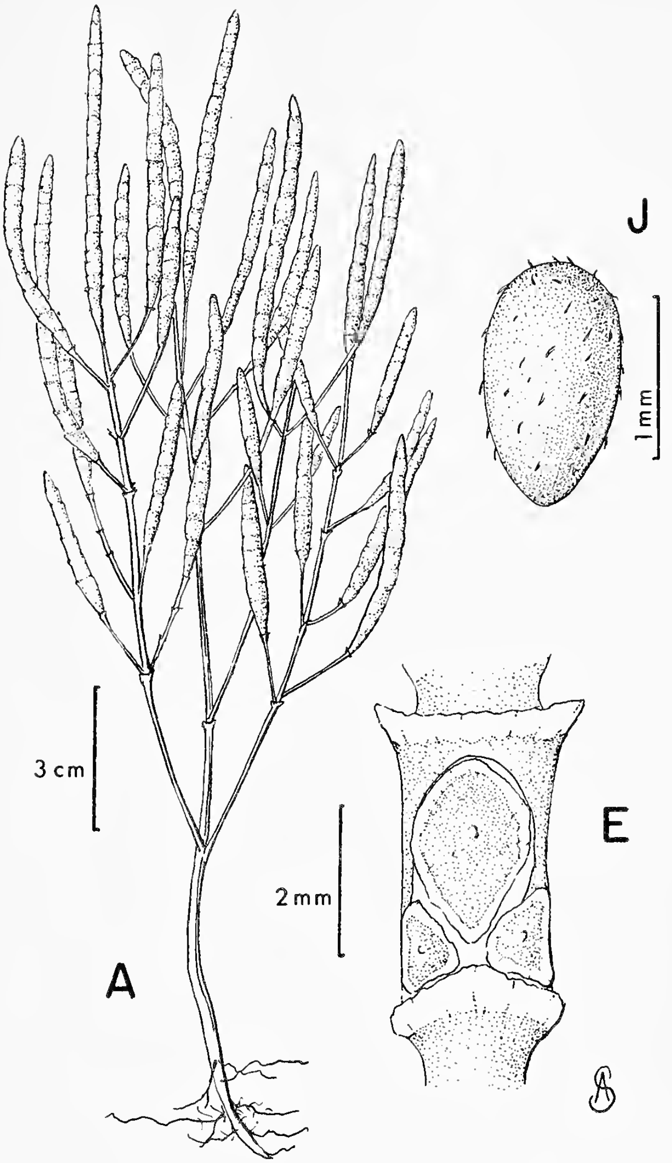
Rarity Status: This species is ranked G5Q S3 by the New York Natural Heritage Program and placed on their watch list.



Description: Plants with **bisexual** flowers; **stigmas** erect to spreading, 0.4-0.5 mm long; **style** 0.2-0.4 mm long; **fruit** ovoid to oblong; **seed** greenish to nearly black, ovoid to oblong, 1.6-2.0 mm long, 1.0-1.2 mm broad, testa covered with short curved hairs; **stamens** 1; **filaments** 1.0-1.2 mm long; **anthers** oblong, yellowish, 0.4-0.7 mm; **calyx** herbaceous, 3-lobed, 0.9-1.1 mm long, the central flower 1.7-1.8 mm tall and 1.3-1.5 mm broad, lateral flowers 1.1-1.2 mm tall and 0.7-1.5 mm broad, the central flower extending nearly or quite to the top of the joint, lateral flowers contiguous below the acute lower angles of the central ones; **inflorescences** erect, cylindrical spikes 2-12 cm long, apex obtuse, the individual joints 1.2-3.5 mm long, 2-6 mm broad, usually much wider than long; **inflorescence scales** triangular, 1.5-3.0 mm long, 2.0-4.8 mm broad, often hiding the flowers, acute, mucronate; **stems** succulent, erect, 0.7-2.0 dm tall, green, usually simple at the base, sparsely to copiously branched above, the branches ascending or rarely spreading, stem joints 7-25 mm long, 2-3 mm broad, the sheaths with 2 sterile scales at the summit, sterile scales 2.9-3.5 mm long and 1.8-3.5 mm broad; **root system** annual with a narrow taproot 2-5 cm long and numerous lateral roots (2n = 18).

Importance: *Salicornia bigelovii* is currently being studied as a potential source of vegetable oil (Glenn *et al.*, 1991). The seeds contain 26-33 percent oil, 31 percent protein, and are low in fiber and ash. The yield equals or exceeds that of oil crops such as soybean and sunflower, and the plant grows in high salinity areas.





3. *Salicornia europaea* L.

Common Names: Glasswort, Samphire, Chicken-claws

Type Description: Linnaeus, Species Pl. 1, p. 3, 1753

Synonyms: *Salicornia europaea* var. *simplex* (Pursh) Fern., *S. prostrata* Pall.

Origin: Native to the Atlantic coast of North America

Habitats: Salt marshes

Habit: Erect to prostrate, annual herb

Flowering: July-September

Fruiting: August-November

General Distribution: In North America from Nova Scotia to Georgia along the coast and inland in saline habitats to Michigan, Wisconsin and Illinois; Europe, Asia and North Africa

Description: Plants with **bisexual** flowers; **stigmas** erect or spreading, 0.2-0.3 mm long; **style** ca. 0.1 mm long; **fruit** oblong to ovoid; **seed** brown, oblong or ovoid, 1.0-1.5 mm long, 0.6-0.8 mm broad, testa covered with short curved hairs; **stamens** 1, rarely 0 or 2; **filaments** 0.3-0.8 mm long; **anthers** oblong, light yellow, 0.3-0.4 mm long; **calyx** herbaceous, 3-lobed, 0.5-0.7 mm long, central flower broadly obovate, 2.0-2.5 mm tall, 1.4-1.5 mm broad, much higher than the lateral flowers and reaching two thirds the distance to the apex of the joint, lateral flowers broadly obovate, 1.2-1.5 mm tall, 0.8-1 mm broad, contiguous below the acute lower angles of the central ones; **inflorescences** erect, cylindrical spikes, 2.5-6.0 cm tall, tapering above, individual joints 2.2-4.0 mm long, 1.5-2.2 (-4.5) mm in diameter, scales obtuse or rounded; **inflorescence scales** very broadly ovoid or forming a shallow cup, 1.0-1.7 mm long, 2.3-2.9 mm broad, apex acute to rounded; **stems** erect, 1-5 dm tall, green becoming red or reddish with age, often simple at the base, usually much-branched above, the branches erect or ascending, joints 5-22 mm long, 1.0-2.5 mm diameter, often reddish in age, the sheaths with two scales at the summit, scales broadly acute, 1.0-1.5 mm long, 1.0-1.5 mm broad; **root system** a slender, annual taproot with numerous lateral fibrous roots (2n = 36).

Nomenclatural Note: This species belongs to a complex group of diploid and tetraploid plants often treated under the inclusive name *S. europaea* L. Typical *S. europaea* (in the narrow sense) is a diploid from northern Europe, but plants ranging along the Atlantic coast south of Canada are tetraploid (Ball, pers. comm.), and would not be placed within *S. europaea* if interpreted in the narrowest sense. The American taxon may be conspecific with a group of European tetraploid annuals, but no studies have been done. If it is not conspecific with any European taxon, then it should be called *S. virginica* L. That binomial has usually been used

for the perennial American plant (here called *S. perennis*), but Ball (pers. comm.) has checked the type of *S. virginica* and found that it is annual. It therefore bears the earliest name for the American tetraploid annual taxon. I have not followed this name change because the American and European populations have not been studied together. Their relationships have not been resolved, and the nomenclature is still confusing. I am, therefore, using *S. europaea* in the broadest, inclusive sense, with the expectation that it may change in the future.

Importance: The fleshy stems of glasswort have culinary importance in France where they are used in several sophisticated recipes. The young stems are also made into pickles in England and Syracuse, New York, and they have, occasionally, been made into salads or used as a garnish. Samphire greens were boiled and served as a survival food for settlers of remote places, particularly in Canada, where their image appears on the Steeves family crest. The plants were also used in medicine (called *herba salicorniae herbaceae*), and occasionally as a source of soda ash for making soap and glass.

2. ATRIPLEX

Common Names: Orach, Salt-bush, Tumbleweed, Atriplex

Authority: Linnaeus, Species Pl. II, p. 1052, 1753

A genus of over 250 species of cosmopolitan distribution, but mainly subtropical and arid-temperate. Many species are halophytes of coastal or inland saline habitats, but a few species are widespread weeds on disturbed soils. A few species are cultivated as ornamentals and pot herbs (particularly *A. hortensis*), while several others are important forage plants. The genus is distinctive among our chenopods because of the accrescent bracteoles that surround the fruit. The species are often considered difficult to distinguish, with hybrids cited as part of that problem (particularly hybrids between *A. patula* and *A. prostrata*), but much of the confusion has been due to the plasticity of the leaves of members of those groups and not to their hybridization. Because the most consistent characters are those of the mature bracteoles, ripe, fruiting specimens should be used for identification whenever possible. Many species have C4-photosynthesis and have a distinctive, net-like venation pattern (kranz-type venation), that can usually be seen by scraping off the surface pubescence of the leaf.

Description: Plants **monoecious** or **dioecious**; **female flowers:** monomorphic or dimorphic: when dimorphic sometimes of two sizes, or with horizontal and vertical seeds; **stigmas** 2, sub-filiform, thickened or compressed toward the connate bases; **style** 1 or absent; **ovary** 1, superior, unilocular with a single, basal **ovule**; **fruit** an indehiscent utricle, surrounded by enlarged bracteoles, the pericarp membranaceous, usually non-adherent but closely investing the seed, the fruit therefore nearly the same size as the seed; **seed** 1, usually vertical, homomorphic or dimorphic (small and black or large and brown), erect or inverted, rarely horizontal (in perianth-bearing flowers), lenticular, testa glabrous; **embryo** annular, surrounding an abundant, farinaceous **perisperm**, the **radicle** inferior, lateral or superior; **calyx** usually absent, sometimes 3-5 lobed and membranaceous, rarely of 1-5 scale-like sepals; **bracteoles** 2, accrescent, distinct or usually united at the base and enclosing the fruit, herbaceous, spongy or cartilaginous, entire or toothed, the dorsal surface smooth or variously appendaged; **male flowers: ovary** rudimentary or absent; **stamens** 3-5, hypogynous; **filaments** linear, distinct or connate at the base; **anthers** tetrasporangiate; **calyx** 3-5 lobed; **bracteoles** lacking; **bracts** absent or subtending glomerules only; **inflorescences** terminal or axillary spikes, panicles or axillary glomerules, the flowers solitary or clustered in glomerules, staminate and pistillate flowers in the same glomerule or glomerules wholly staminate towards the tips; **leaves** opposite or alternate, herbaceous, sessile or petioled, venation of the kranz-type or normal dicotyledonous type; **stems** herbaceous or woody (shrubby), more or less scurfy, farinose or furfuraceous with vesicular hairs; **root systems** annual or perennial.

KEY TO SPECIES

1. Principal leaves with serrate margins; blades with net-like, kranz-type venation (may require scraping surface to see)........(2)
1. Principal leaves entire or with only two teeth towards the base; blades lacking kranz-type venation ....(3)
    2. Flowers borne primarily on terminal, bractless, often long spikes, rarely with a few axillary glomerules ....1. *A. tatarica*
    2. Flowers borne primarily in axillary glomerules, except for a short, terminal, male spike ....2. *A. rosea*
3. Principal lower leaves linear to lanceolate or elliptic; leaf bases cuneate ....(4)
3. Principal lower leaves ovate to triangular; leaf bases subcordate, truncate or broadly cuneate ....(7)
    4. Bracteoles obtriangular, broadest above the middle, with 3-5 teeth toward the apex; leaves densely pubescent ....3. *A. arenaria*
    4. Bracteoles broadly ovoid, triangular or diamond shape, broadest at or usually below the middle, without teeth along the apex; leaves sparsely pubescent ....(5)

5. Inflorescence with leafy bracts throughout; black seeds rare or absent; brown seeds with the radicle strongly ascending . ...4. *A. glabriuscula*

5. Inflorescence with leafy bracts only at the base; black seeds common; brown seeds with the radicles not strongly ascending ....(6)

6. Bracteoles broadly triangular to ovate-triangular, usually thick with well-developed spongy inner layer (sometimes lacking); leaves linear to linear-lanceolate; brown seeds 2-3 mm wide, broadly elliptic, more or less basally flat, the radicle median, ascending to pointing outward with the apex curved inward ....5. *A. subspicata*

6. Bracteoles rhombic-triangular to triangular-hastate, always thin and lacking a spongy inner layer; leaves linear- lanceolate to lanceolate; brown seeds 2.5-3.1 (3.7) mm wide, round, not basally flattened, the radicle subbasal, ascending with apex pointed ....6. *A. patula*

7. Fruiting bracteoles orbicular or rounded-ovate, 10 mm broad or more, conspicuously reticulate-veined; seed apparently centrally placed within the bracteoles ....7. *A. hortensis*

7. Fruiting bracteoles triangular or rhomboidal, less than 5 mm broad, not conspicuously veined; seed basally placed within the bracteoles ....(8)

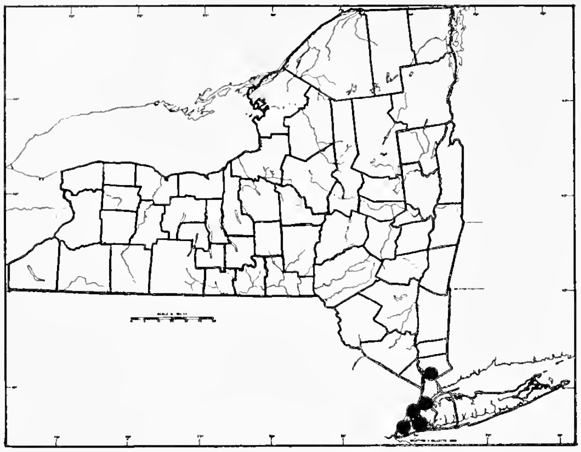
8. Inflorescences with leafy bracts only at the base ....(9)

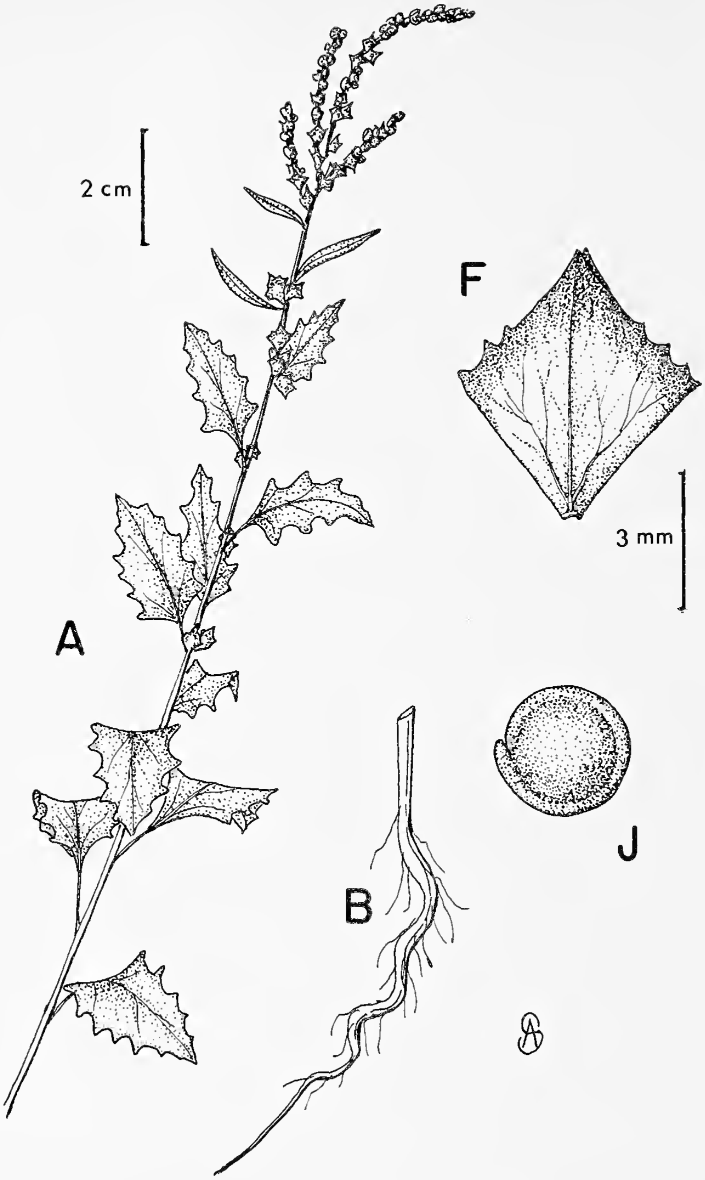
8. Inflorescences with leafy bracts throughout ....4. *A. glabriuscula*

9. Principal leaves usually lanceolate with two teeth pointing towards the apex; bracteoles without a spongy inner layer, rhombic-triangular to triangular-hastate with prominent lateral angles ....6. *A. patula*

9. Principal leaves triangular-hastate, usually with two teeth pointing towards the base; bracteoles with inner spongy layer present (sometimes weakly developed), triangular-hastate to triangular-ovate or broadly ovate; with prominent basal angles ....8. *A. prostrata*

Note: Because fruit and seed measurements are virtually the same in this genus, only the seed sizes are given in the descriptions that follow.





1. ***Atriplex tatarica*** **L.**

Common Names: Tartarian Saltbush, Orach, Atriplex

Type Description: Linnaeus, Species Pl. II, p. 1053, 1753

Origin: A native of Europe

Habitats: Waste places and ballast

Habit: Erect to spreading, annual herbs

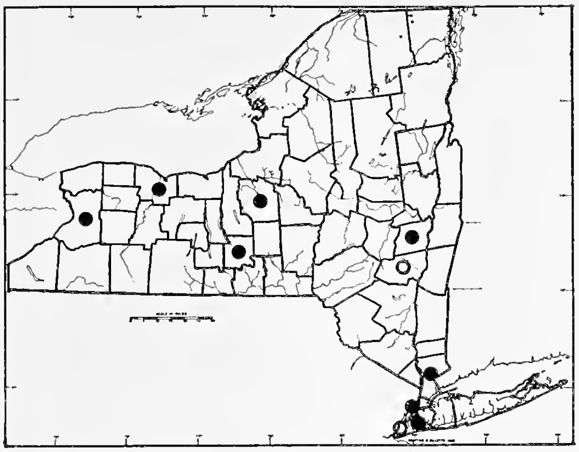
Flowering: July-August

Fruiting: September

General Distribution: Europe, Asia, the East Indies and northern Africa; adventive in North America: Connecticut, New York, New Jersey, Pennsylvania and elsewhere as a ballast waif

Description: Plants **monoecious; female flowers:** monomorphic; **stigmas** erect or spreading, 0.6-1.8 mm long; **style** 0.2-0.3 mm long; **ovary** spheroid; **fruit** subrotund, pericarp non-adherent; **seed** brownish, 1.5-2.0 mm in diameter, 0.2-0.3 mm thick, the **radicle** ascending; **perianth** absent; **bracteoles** 2, subsessile, rhombic, 3-7 (-15) mm long, 3.0-4.8 mm broad, not compressed, united to the middle, apex foliaceous, acutely 3-lobed and often denticulate, the sides commonly tuberculate or sometimes smooth; **male flowers: stamens** 5; **filaments** membranaceous, 0.6-0.8 mm long; **anthers** ellipsoid, yellow-orange, 0.3-0.4 mm long; **perianth** 5-lobed, **lobes** scarious, oblong-ovate, 0.5-0.9 mm long, 0.5-0.7 mm broad, apex acute; **bracts** absent; **inflorescences** of glomerules of female flowers in the axils of leaves and in terminal or axillary spikes of either all male flowers or male and female flowers, spikes 2-5 cm long, 2-3 mm broad; **leaves** alternate with kranz-type venation, triangular-rhombic or deltoid usually hastate or subhastate, 2-7 (-10) cm long, 1.0-4.2 (-7) cm broad, apex obtuse to acute, base subtruncate, often hastate, deeply or shallowly sinuate-dentate or rarely undulate, thin, densely whitish-furfuraceous beneath, usually green and glabrate on the upper surface; **petioles** 0.5-1.2 cm long; **stems** erect or ascending, sparsely to densely branched, the branches erect, ascending, or rarely procumbent, 3-15 dm long, slender to stout, obtusely angled, furfuraceous when young, glabrate in age; **root system** an annual taproot (2n = 18).

Importance: This species may be used as a source of potash and was once used in folk medicine.



2. *Atriplex rosea* L.

Common Names: Red Orach, Rosy Orach, Tumbleweed, Tumbling Orach

Type Description: Linnaeus, Species Pl. ed. 2, II, p. 1493, 1763

Synonym: *Atriplex spatiosa* A. Nelson

Origin: Native to the Mediterranean region of Europe

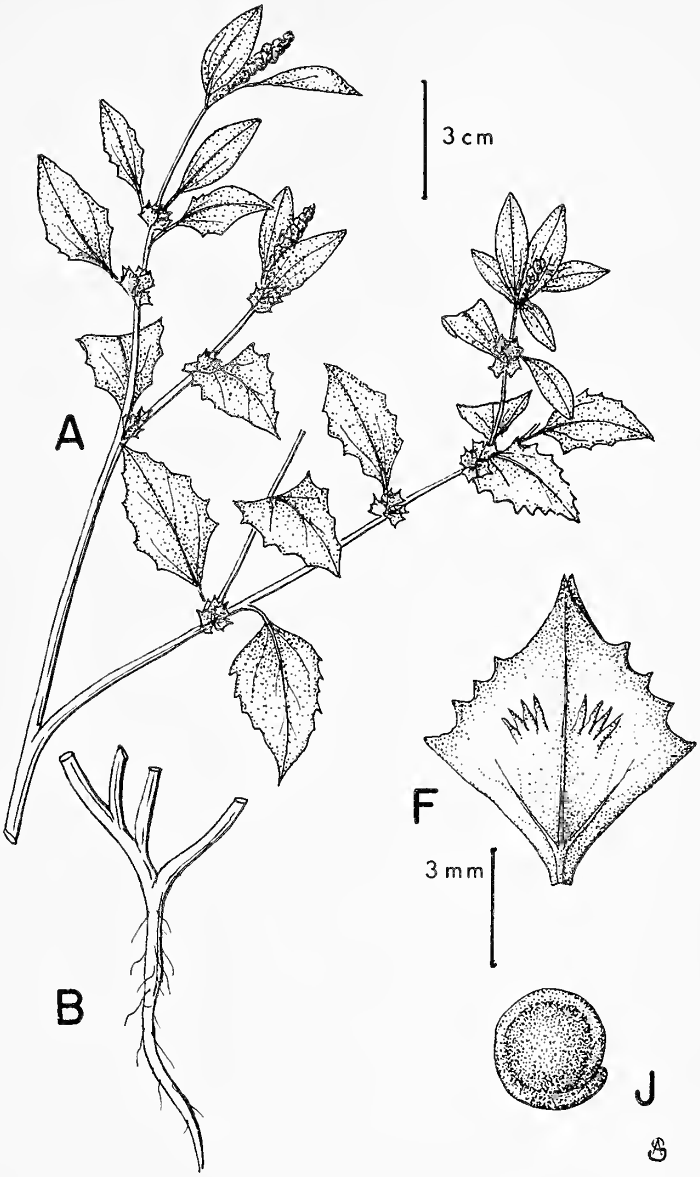
Habitats: Roadsides and a variety of disturbed habitats

Habit: Erect or ascending, annual herbs

Flowering: July-August

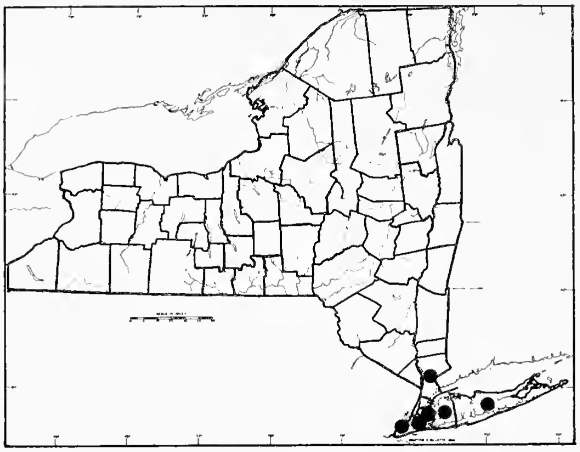
Fruiting: July-October

General Distribution: Mediterranean region, Asia, and Australia; introduced in North America from Nova Scotia to British Columbia south to California and New York



Description: Plants **monoecious**; **female flowers:** monomorphic; **stigmas** erect to spreading, 0.4-0.5 mm long; **style** ca. 0.5 mm long; **ovary** obovoid; **fruit** subrotund, pericarp adherent; **seed** dull brown, subrotund, 2.0-2.3 mm in diameter, 0.6-0.8 mm thick, the **radicle** lateral; **perianth** absent; **bracteoles** 2, subsessile, rhombic or ovate, 3-6 (-12) mm long, 3-6 (-8) mm broad, margin dentate, united to near the middle, the surface usually short-tuberculate, becoming hardened at the base; **male flowers: stamens** 5; **filaments** membranaceous, 0.4-0.7 mm long; **anthers** oblong, yellow-orange, 0.3-0.4 mm long; **perianth** 4-5 lobed; **lobes** scarious, oblong-ovate, 0.3-0.5 mm long, 0.3-0.4 mm broad, apex acute; **inflorescences** of glomerules in the axil of leaves, spikes of sessile glomerules and usually short, interrupted, terminal, staminate spikes; **glomerules** bisexual or all male, subglobose, the bisexual glomerules 2-4 flowered, 0.3-0.9 cm in diameter, the terminal male glomerules globose, 0.2-0.3 cm in diameter; **leaves** alternate except the lowermost, with kranz-type venation, ovate or rhombic-ovate to lanceolate, 1.5-7.5 cm long, 0.7-6.0 cm broad, apex acute to somewhat obtuse, base cuneate or rounded, sinuate-dentate above the base, usually grey to whitish, often becoming hard and persistent with age; **petioles** 0-15 mm long; **stems** erect to ascending, 1-20 dm tall, much-branched, the lateral branches ascending or spreading, terete, mealy or glabrous; **root system** annual with a taproot (2n = 18).

Importance: The herbage is used to make potash in Greece and its extract finds limited use in medicine as an antiscorbutic and corrective for scrofula. In the western United States, where the species is widely naturalized, it is said to be the cheapest and most satisfactory hog feed, highly prized for fattening swine. The pollen of this species has also been implicated as a causative factor in hay fever in the western United States.



3. *Atriplex arenaria* Nutt.

Common Names: Seabeach Orach, Seabeach Atriplex

Type Description: Nuttall, Gen. N. Amer. Pl. 1: 198, 1818

Synonyms: *Atriplex cristata* var. *arenaria* (Nutt.) Kuntze, *A. pentandra* ssp. *arenaria* (Nutt.) Hall & Clements, *A. mucronata* Raf., *Obione arenaria* (Nutt.) Moq.

Origin: Native to the North Atlantic Coast of North America

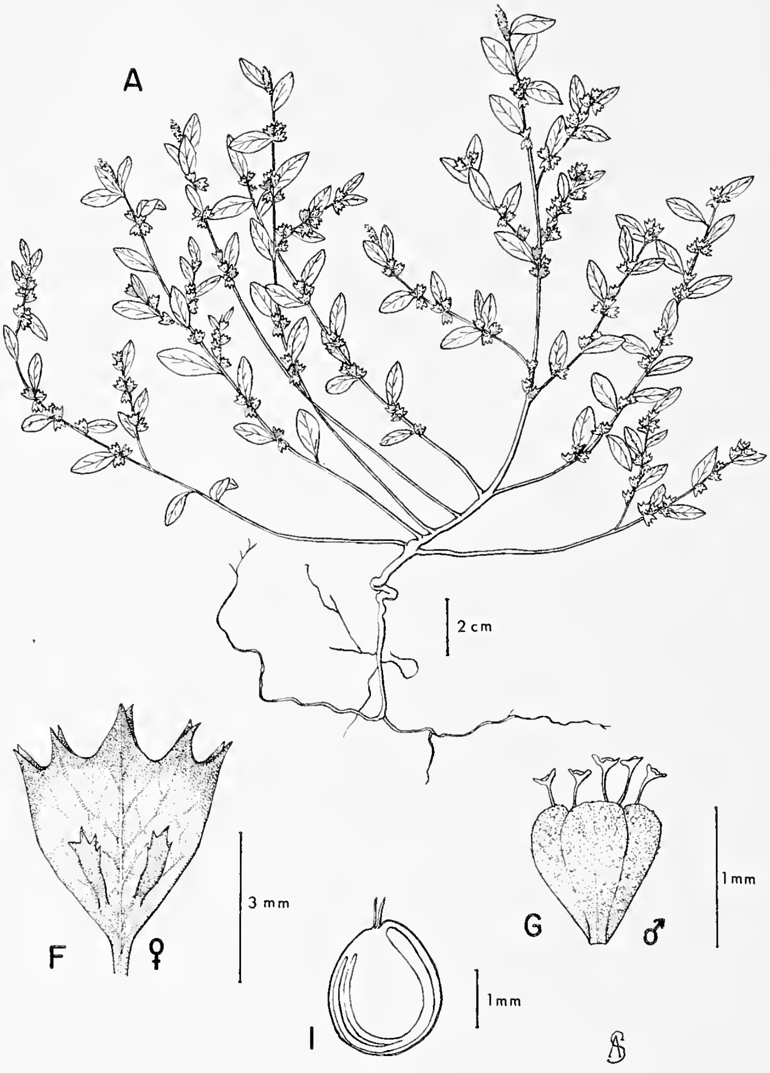
Habitats: Sandy seashores and margins of salt marshes

Habit: Erect to procumbent, annual herbs

Flowering: August-September

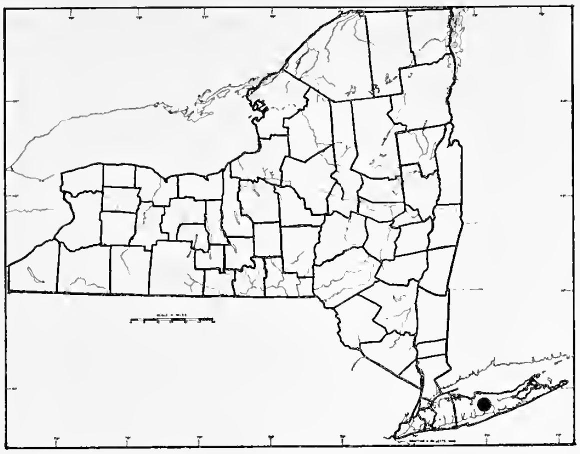
Fruiting: August-December

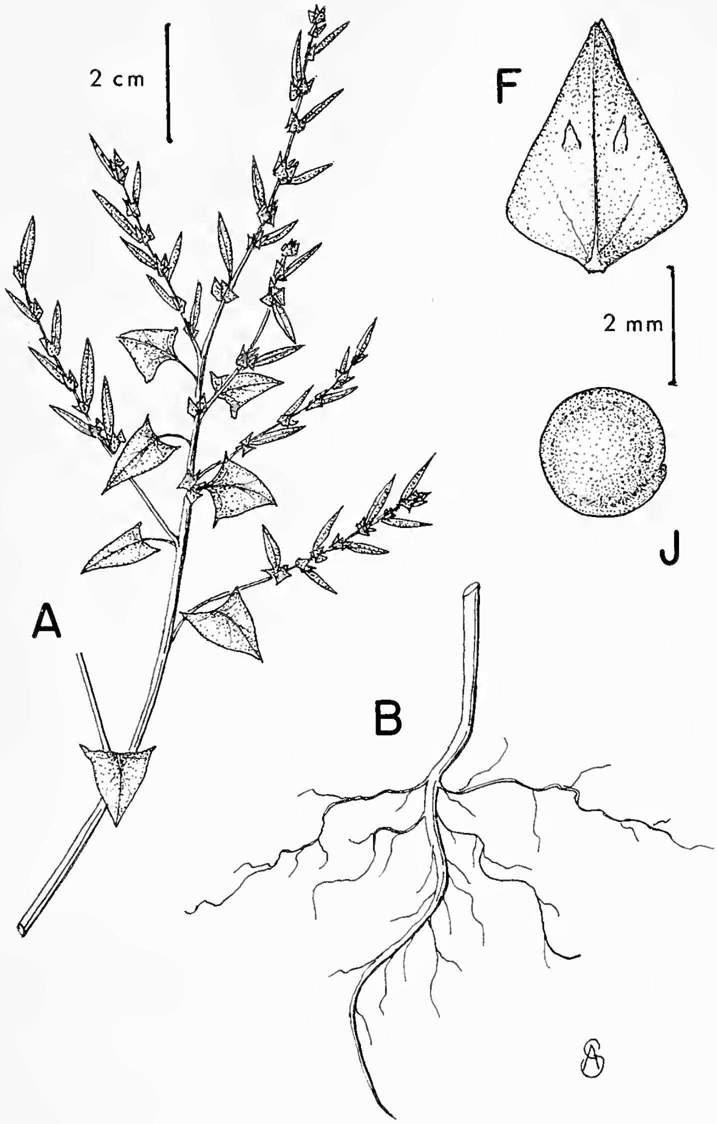
General Distribution: Along the Atlantic coast from New Hampshire to Virginia



Description: Plants **monoecious; female flowers:** monomorphic; **stigmas** erect or spreading, 0.6-1.0 mm long; **style** ca. 0.1 mm long; **ovary** ovoid; **fruit** subrotund, pericarp adherent; **seed** reddish-brown, subrotund, 1.5-2.8 mm in diameter, 0.4-0.5 mm thick, the **radicle** superior; **perianth** absent; **bracteoles** 2, subsessile, obovate to orbicular-obovate, 3.5-7.5 mm long, 4.5-7.5 mm broad, compressed, united to the middle, the apex rounded, sharply dentate above the middle, teeth 3-5, broadly triangular, subequal or the terminal longer than the lateral, bracteole backs with 2 lateral, irregular, dentate crests, or occasionally tuberculate, rarely lacking appendages; **male flowers: stamens** 5; **filaments** membranaceous, 0.4-0.6 mm long; **anthers** ovoid, yellow-orange, 0.3-0.4 mm long; **perianth** 5-lobed; **lobes** scarious, oblong-ovate, 0.4-0.5 mm long, 0.4-0.6 mm broad, apex acute; **female** (and **polygamous**) **inflorescences** of glomerules in the axils of the upper leaves, (usually with some male flowers intermixed); **male inflorescences** terminal spikes, 0.5-3.0 cm long, 2.5-3.5 mm broad, often deciduous from mature plants; **glomerules** bisexual, or male only, subglobose, male glomerules 2-3 mm diameter, mixed glomerules 6-10 mm in diameter; **leaves** alternate, lacking kranz-type venation, oblong, oval, broadly obovate or narrowly oblong, 1.2-4.0 cm long, 0.4-1.5 cm broad, rounded to acute at the apex, mucronate, rounded to cuneate at the base, entire or undulate, rarely with 1-2 teeth, thin, densely whitish-furfuraceous beneath, grayish green or glabrate above; **petioles** 0-2 mm long; **stems** erect, ascending or procumbent, much-branched, lateral branches procumbent, 1-5 dm long; annual with a branched **root system.**

Infraspecific Variation: This species is closely related to a native of the southeastern U.S. coast, *A. pentandra* (Jacq.) Standl., and has been treated as a subspecies by Hall & Clements (1923).





4. ***Atriplex glabriuscula*** **Edmondston**

Common Name: Seaside Orach

Type Description: Edmondston, Fl. Shetland, p. 39, 1845

Synonyms: *Atriplex glabriuscula* var. *oblanceolata* Victorin & Rousseau, *A. patula* ssp. *glabriuscula* (Edmondston) H. M. Hall & Clements, *A. patula* var. *oblanceolata* (Victorin & Rousseau) Boivín

Origin: Native to the Northern Atlantic coasts of Europe and North America

Habitats: Coastal sands and salt marshes

Habit: Erect, procumbent or prostrate perennial herbs

Flowering: August

Fruiting: September

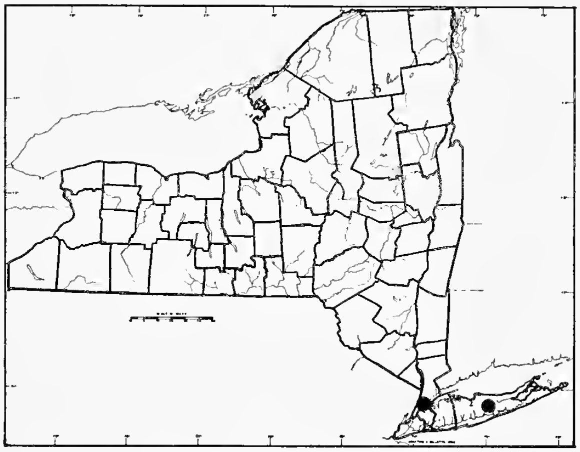
General Distribution: Northwestern Europe and Iceland, and in North America from Greenland to the Northwest Territories south to New England and New York

Rarity Status: This species is ranked G4 SH by the New York Natural Heritage Program

Description: Plants **monoecious**; **female flowers:** monomorphic; **stigmas** erect or spreading, 0.4-0.5 mm long; **style** 0-0.1 mm long; **ovary** ovoid; **fruit** spherical to oval, pericarp adherent; **seeds** dimorphic (with some intermediates): brown or black, brown seeds oval or rounded, 2-3 mm in diameter, 0.2-0.4 mm thick, with the **radicle** subbasal to median, obliquely pointing outward, the apex blunt, black seeds spheroid to oval, 1.1-1.4 mm in diameter, 0.2-0.4 mm thick, the **radical** subbasal; **perianth** absent; **bracteoles** 2, often with a foot-stalk when arising from leaf axil, triangular-hastate, 3-5 (-11) mm long, 2.7-4.0 mm broad, green, often reddish becoming brown to black with maturity, apex acute to acuminate, base truncate to subcordate or obtuse, margins united at the base, denticulate to laciniate, dorsal surface smooth convex, rarely with two small tubercles, spongy inner layer strongly or weakly developed; **male flowers: stamens** 5; **filaments** membranaceous, ca. 0.6 mm long; **anthers** ellipsoid, yellow-orange, ca. 0.4 mm long; **perianth** 5-lobed; **lobes** scarious, oblong-ovate, ca. 0.5 mm long, ca. 0.5 mm broad, apex acute; **bracts** lanceolate, 0.4-1.1 cm long, 0.2-0.6 cm broad; **inflorescences** single flowers or glomerules in the axil of reduced upper leaves, the uppermost clusters occasionally without bracts and therefore forming a terminal spike; **glomerules** bisexual, subglobose, 2-5 flowered, 3-4 mm in diameter; **leaves** alternate, lacking kranz-type venation, lower leaves: triangular-hastate with a pair of broad-based up-curving acute lobes pointing outward, 4-8 cm long, 0.4-1.5 cm broad, apex acute, base truncate, irregularly serrate to sinuate-dentate above the lobes, glabrous or finely farinose, upper leaves: lance-hastate with a pair of out-pointing to up-curving basal lobes or lanceolate and lacking lobes, smaller than lower leaves, sessile to subsessile; **petioles** on lower leaves 1.5-2.5 mm

long, upper leaves sessile or subsessile; **stems** prostrate, decumbent or erect, few branched, branches asymmetric, the lowermost wide-spreading and the first 3-6 (-8) pairs opposite, becoming alternate above, stems subangular, green, often red-striped, becoming tough-woody toward the base, straight, 0.5-1.7 dm long; **root system** annual with a taproot (2n = 18).

Infraspecific Variation: The seeds are dimorphic, but brown, convex intermediate seeds are relatively common, and both seed types are often slightly wider than long.



5. *Atriplex subspicata* (Nutt.) Rydberg

Common Name: Orach

Type Description: Nuttall, Gen. N. Amer. Pl. 1: 199, 1818

Synonyms: *Atriplex carnosa* Nelson, *A. lapathifolia* Rydberg, *A. patula* var. *subspicata* (Nutt.) S. Watson, *Chenopodium subspicatum* Nutt.

Origin: Native to North America

Habitats: Saline and alkaline soils in waste places

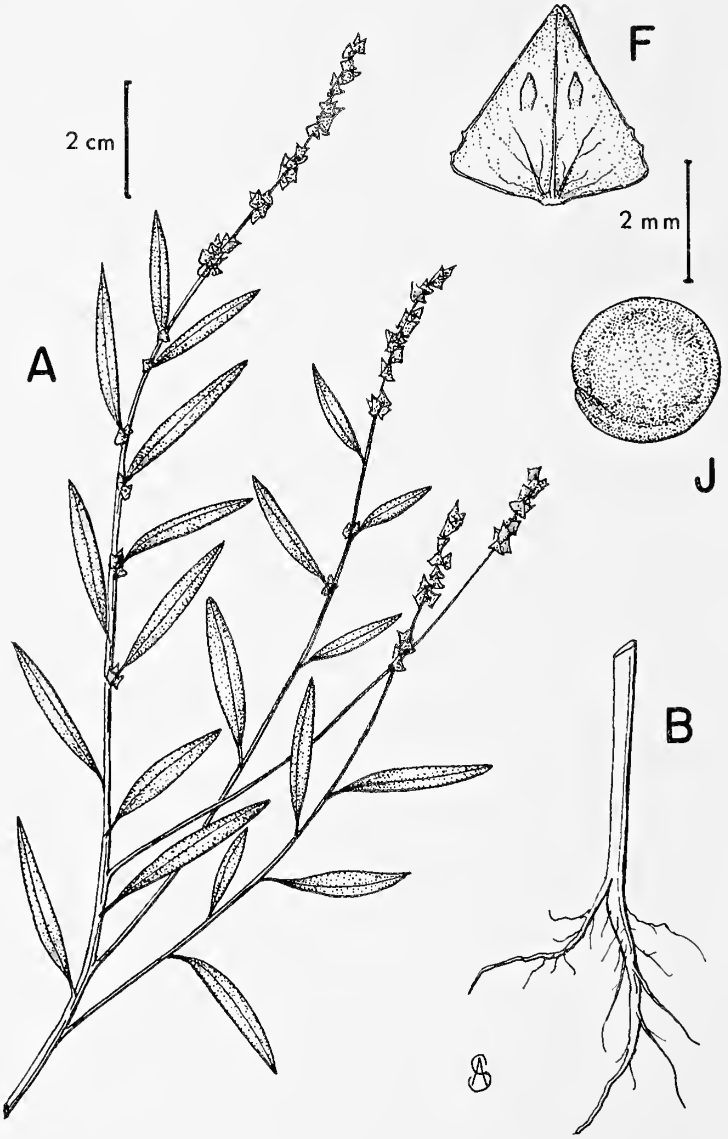
Habit: Erect annual herbs

Flowering: July-September

Fruiting: August-November

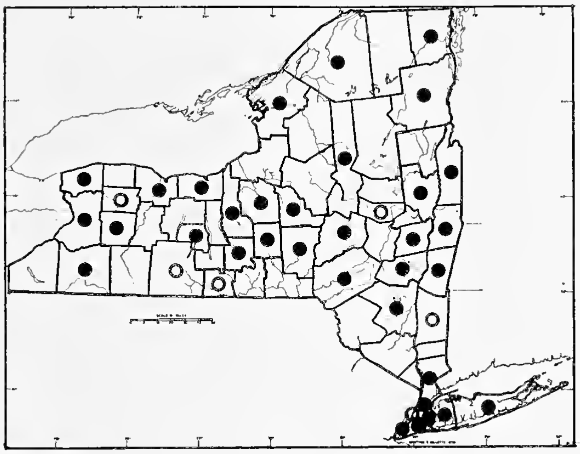
General Distribution: Newfoundland to British Columbia south to California, Utah, Oklahoma and North Carolina

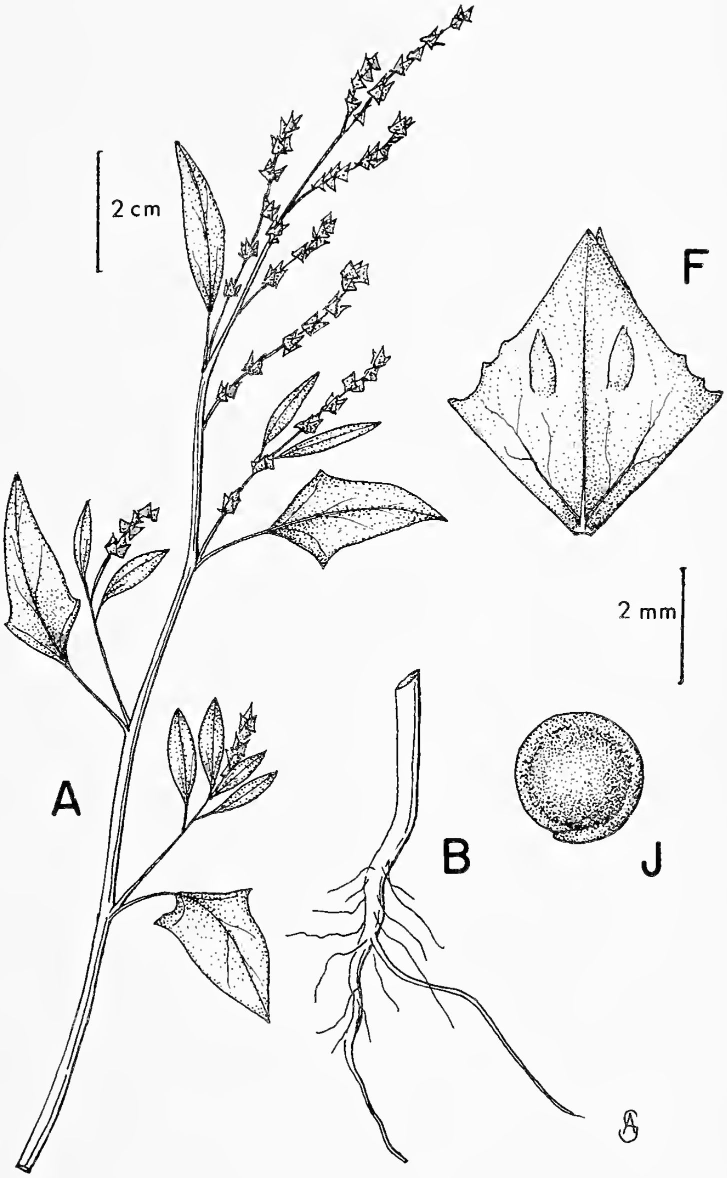
Rarity Status: *Atriplex subspicata* is ranked G5 SH by the New York Natural Heritage Program.



Description: Plants **monoecious**; **female flowers:** monomorphic; **stigmas** erect or spreading, 0.2-0.3 mm long; **style** absent; **ovary** ovoid; **fruit** depressed ellipsoid, pericarp adherent; **seeds** dimorphic: brown or black, the brown seeds depressed ellipsoid, (1.5-) 2.1-2.6 mm long, 2.4-3.0 mm broad, ca. 0.7 mm thick, the **radicle** generally median ascending with apex abruptly incurved, the black seeds depressed-ellipsoid, (1.4-) 2.5-3.1 mm long, (1.7-) 2.8-3.4 mm broad, ca. 0.7 mm thick, convex, rounded, the **radicle** generally basal, with the apex incurved; **perianth** absent; **bracteoles** 2, sessile, thick, green, blackening with maturity, broadly triangular to ovate triangular, 3.0-5.4 mm long, 4.2-4.5 mm broad, usually longer than wide, margins entire or occasionally with sharp teeth, dorsal surface with one or more tubercles with an inflated inner spongy layer, the surface rarely smooth; **male flowers:** not seen in New York material; **bracts** absent or leaf-like; **inflorescences** terminal and axillary spikes or with a few leafy bracts toward the base, spikes 5-10 cm long; **glomerules** bisexual, subglobose to irregularly globular, 0.8-1.0 mm in diameter; **leaves** alternate, lacking kranz-type venation, lanceolate to narrowly lanceolate or linear, rarely ovate to oblong, often with a

pair of outwardly pointing to forward-curving obtuse lobes, 2.5-4.0 (-12) cm long, 0.2-6.0 cm broad, apex acuminate, base cuneate, margins irregularly broad-toothed or entire, green to grayish green, often reddish at or toward maturity, succulent; **petioles** 1-3 cm long; **stems** erect or occasionally semierect, 3-15 dm tall, branches 1-many, alternate except for the 2-3 lowermost opposite pairs, stems angular, with light green to green or occasionally red to reddish stripes; **root system** annual with a taproot (2n = 36, 54).





6. ***Atriplex patula*** **L.**

Common Names: Seaside Orach, Seaside Atriplex, Spearscale

Type Description: Linnaeus, Species Pl. II, p. 1053, 1753

Synonyms: *Atriplex angustifolia sensu* Smith, *A. patula* var. *bracteata* of authors, not Westerlund, *A. patula* var. *littoralis* A. Gray

Origin: Circumboreal in distribution

Habitats: Saline and brackish areas near the coast; edges of sidewalks, lawns, roads, margins of beaches and other disturbed areas

Habit: Erect to prostrate, annual herbs

Flowering: July-September

Fruiting: August-October

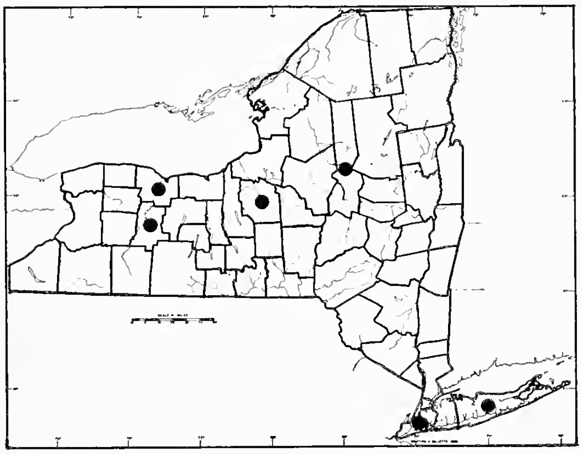
General Distribution: Eurasia; in North America, widely distributed from Newfoundland to British Columbia south to Missouri, Illinois and North Carolina

Description: Plants **monoecious**; **female flowers:** monomorphic; **stigmas** spreading, 0.4-0.6 mm long; **style** absent; **ovary** ovoid; **fruit** oval or orbicular, pericarp adherent; **seeds** dimorphic: brown and black, the brown seeds orbicular, 2-3 (-3.5) mm in diameter, 0.8-1.0 mm thick, the **radicle** inferior, subbasal, the ascending apex pointed, black seeds oval, 1.6-2.0 mm in diameter, 0.6-0.8 mm thick, often wider above the radicle, the **radical** basal, pointing outward; **perianth** absent; **bracteoles** 2, subsessile, rhombic-triangular to triangular-hastate, 3-6 (-20) mm long, 2.5-5.0 mm broad, green becoming blackened at maturity, united almost to the middle, apex acute to acuminate, base cuneate to broadly obtuse, with lateral angles prominent and usually strongly developed, entire or with 1 or 2 teeth at the lateral angles, dorsal surface smooth or with irregular, laciniate appendages, foliaceous, thin, lacking a spongy inner layer, venation obscure or the midvein alone prominent; **male flowers: stamens** 5; **filaments** membranaceous, ca. 0.6 mm long; **anthers** ovoid, yellow-orange, 0.4-0.5 mm long; **perianth** 5-lobed; **lobes** scarious, oblong-

ovate, 0.5-0.7 mm long, 0.4-0.5 mm broad, apex acute; **bracts** absent; **inflorescences** terminal and axillary, flexuous spikes 3-12 cm long, formed from widely spaced sessile glomerules, the lower glomerules in the axil of reduced leaves the upper bractless; **glomerules** bisexual, subglobose, 5-15 flowered, 0.3-1.0 cm in diameter; **leaves** alternate, lacking kranz-type venation, oblong, oval, broadly obovate or narrowly oblong, 1.2-7.0 (-14) cm long, 0.4-4.0 (-6) cm wide, rounded to acute at the apex, mucronate, rounded to cuneate at the base, entire, undulate, or undulate-dentate, rarely with 1-2 teeth, or 1-2 lobes, outward or apically pointing, thin, densely whitish-furfuraceous beneath, grayish green or glabrate above; **petioles** 0.4-1.3 cm long; **stems** erect, ascending or procumbent, strongly ridged, much-branched, branches 1-5 dm long; **root system** annual with a branched taproot and fibrous lateral roots (2n = 36).

Taxonomic Note: This species and *A. prostrata* are often confused or treated as varieties of a single species. In fruit, the two species are easily distinguished, in that *A. patula* has narrow, rhomboid to triangular bracteoles without much of a spongy layer. The leaves are cuneate at the base, often with two lobes pointing toward to apex. Much of the difficulty in identification has been attributed to hybridization, but I have found very few putative hybrids between these two species.

Importance: Extracts from plants of this species have occasionally been used in folk medicine to cure headaches, "wandering pains" and rheumatism.



7. *Atriplex hortensis* L.

Common Names: Garden Orach, Mountain Spinach, Garden Atriplex, Garden Scale, Butter-leaves, Wild Beet

Type Description: Linnaeus, Species Pl. II, p. 1053, 1753

Synonyms: *Atriplex nitens* Schkuhr, *A. sagittata* Borkhausen

Origin: A native of Asia (Tartary)

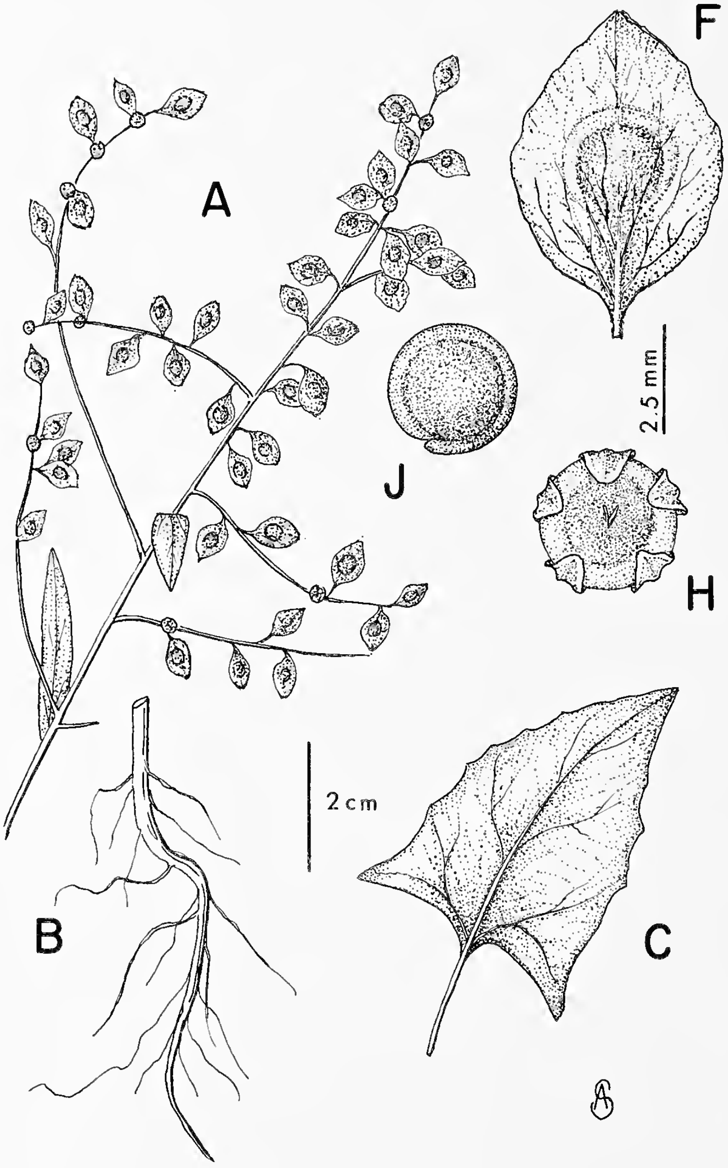
Habitats: Weedy areas and disturbed ground, especially around gardens

Habit: Erect, annual herb

Flowering: August

Fruiting: August-October

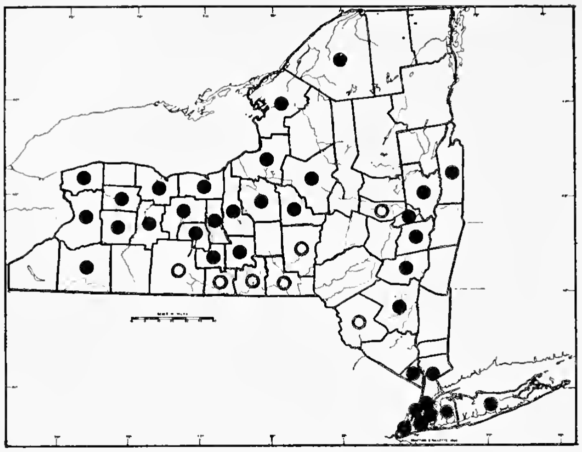
Distribution: Asia, and naturalized throughout central and southern Europe; in North America from Quebec to Alaska south to Utah, Illinois and New Jersey (Cuba)

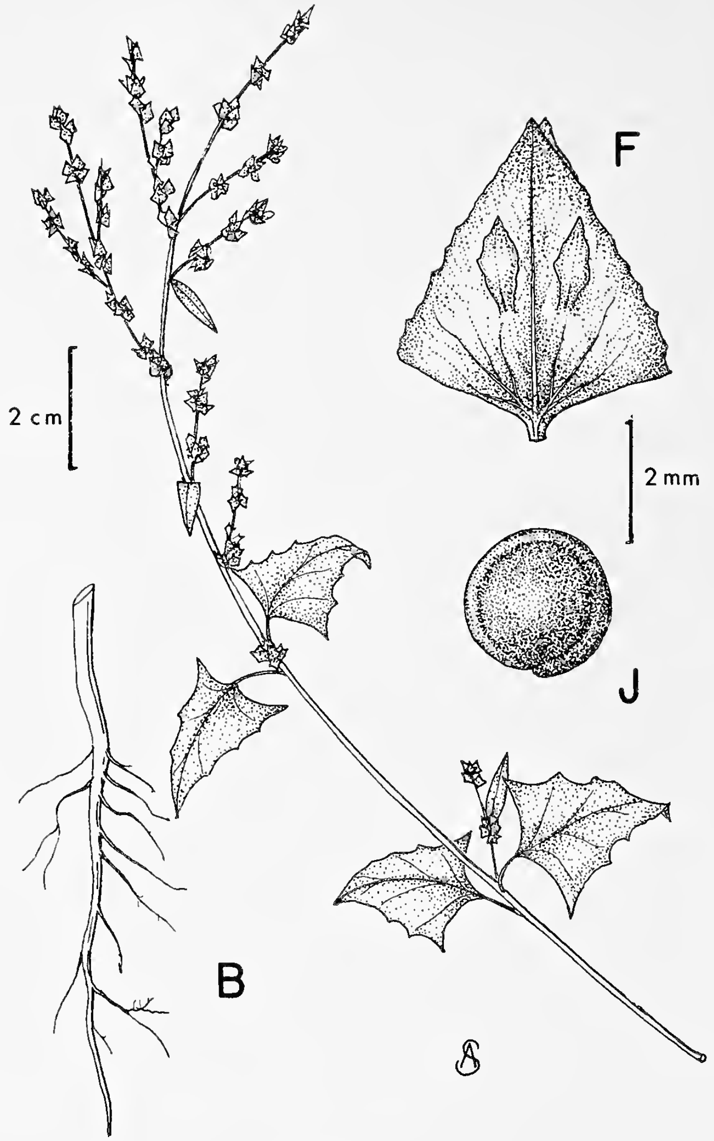


Description: Plants **monoecious**; **female flowers**: dimorphic, some lacking bracteoles, but with a 5-parted perianth, most flowers with 2 bracteoles, but lacking a perianth; **stigmas** erect or spreading, ca. 0.2 mm long; **style** ca. 0.1 mm long or absent; **ovary** ovoid; **fruit** oval or depressed-ovoid, the pericarp non-adherent; **seeds** trimorphic: perianth-bearing flowers with horizontal, biconvex, black seeds, oval, 1.4-1.6 (-2) mm in diameter, 0.4-0.8 mm thick, bracteolate flowers bearing 2 seed-types: vertical, black or yellowish-brown seeds, the black seeds, flat, oval, 1.8-2.0 (-4) mm in diameter, 0.4-0.8 mm thick, yellowish-brown seeds oval, 1.2-1.4 mm in diameter, 0.3-0.6 mm thick, **radicle** vertical; **perianth** 3-5 lobed on flowers without enlarged bracteoles (absent from flowers with enlarged bracteoles); **perianth lobes** scarious, oblong, 0.5-0.7 mm long, ca. 0.2 mm broad, apex obtuse; **bracteoles** orbicular, the size variable, from 4-10 mm long and 3-7 mm broad, larger in cultivated specimens, united at the base, veined; **male flowers: stamens** 5; **filaments** membranaceous, 0.3-0.4 mm long; **anthers** ellipsoid, orange, 0.2-0.3 mm long; **perianth** 5-lobed; **lobes** oblong, 0.5-0.7 mm long, 0.4-0.5 mm broad, apex obtuse; **bracts** absent; **inflorescences** terminal and axillary, slender spikes mostly 2-8 cm long, the terminal spikes usually arranged in a panicle; **glomerules** bisexual or occasionally only staminate, 2-8 flowered; **leaves** alternate, lacking kranz-type venation, triangular or ovate-triangular, hastate, 4-12 (-20) cm long, 1-7 cm broad, apex acute or obtuse, base rounded, truncate, or subcordate, margin entire or irregularly dentate, mealy, becoming glabrous and green; **petioles** 0.5-3.0 cm long; **stems** erect or half-decumbent, widely branched from the base, (5-) 15-25 (-30) dm tall; **root system** annual with a taproot ($2n = 18$).

Infraspecific Variation: The plants that escape from cultivation within our range appear to be the same as Eurasian *A. hortensis* ssp. *nitens* (Schkuhr) Pons., with scurfy lower leaf surfaces and ovate-cordate bracteoles. But, as Hall and Clements (1923) have pointed out, these characters do not seem to be adequate for separating many specimens from typical *A. hortensis*. Several authors have suggested that the cultivated *A. hortensis* is derived through selection from *A. hortensis* ssp. *nitens*, and it appears that the escaped and naturalized plants may be reverting back to their ancestral phenotypes.

Importance: Garden Orach has been used as a kitchen vegetable since antiquity. The Greeks and Romans used it much like Spinach, boiling the leaves. Although it is considered inferior to Spinach, it is still used in greens mixtures to a limited extent, especially, to correct the acidity and color of sorrel (*Oxalis*). The leaves are high in Vitamin C content. A red color-variant (var. *atrosanguinea* Hort.) is sometimes grown as an ornamental herb. The seeds are used in the Russia and the Baltic nations to produce a blue dye; the plants were once crushed and mixed with wine as a reputed cure for yellow jaundice.





8. *Atriplex prostrata* Boucher ex DC. in Lam. & DC.

Common Names: Orach, Spearscale

Type Description: Boucher ex DeCandolle in Lamarck & DeCandolle, Fl. Franç, p. 387, 1805

Synonyms: *Atriplex deltoides* Babington, *A. hastata sensu* Aellen, not L., *A. oppositifolia* DC., *A. triangularis* Willd.

Origin: Of uncertain origin; very widespread and perhaps native to northern Europe

Habitats: Saline and brackish soils near the coast; waste places, occasionally in cultivated fields inland

Habit: Erect, decumbent or procumbent, annual herbs

Flowering: August-September

Fruiting: September

General Distribution: Europe, Asia and North Africa; in North America from Nova Scotia west to British Columbia south to Illinois Missouri and South Carolina

Description: Plants **monoecious**; **female flowers:** monomorphic; **stigmas** erect or spreading, 0.2-0.3 mm long; **style** absent; **ovary** ovoid; **fruit** oval, pericarp adherent; **seeds** dimorphic: brown and black, the brown seeds oval, (1.5-) 2.1-2.5 mm in diameter, 0.5-0.6 mm thick, the **radicle** subbasal, subascending or out-pointing with a blunt, not free apex, black seeds oval, (1-) 1.3-1.8 mm in diameter, 0.4-0.5 mm thick, the **radical** basal, out-pointing; **perianth** absent; **bracteoles** subsessile, triangular-hastate to triangular-ovate or broadly ovate, 1.4-5.2 mm long, 2-5 mm broad, green becoming brown to black at maturity, margins united at the base, apex broadly to moderately acute, the base truncate to obtuse with the lateral angles rounded, entire or with a pair of short teeth at the apex and sometimes at the lateral angles, the dorsal surface smooth or with 2 (often muricate) tubercles, foliaceous or more or less inflated, a spongy inner layer present, but usually weakly developed, venation obscure or prominent; **male flowers: stamens** 5; **filaments** membranaceous, 0.2-0.4 mm long; **anthers** ellipsoid, yellow-orange, 0.2-0.3 mm long; **perianth** 5-lobed; **lobes** scarious, oblong-ovate, 0.3-0.4 mm long, 0.3-0.5 mm broad, apex acute; **bracts** absent or lanceolate, up to 3 cm long and 1 cm broad; **inflorescences** terminal and axillary spikes, occasionally with leafy bracts at the base, 2-20 cm long, composed of well-spaced glomerules; **glomerules** bisexual, or the terminal ones wholly staminate, irregularly globose, 6-8 flowered, 0.3-1.2 cm in diameter; **leaves** alternate, lacking kranz-type venation, the lower leaves triangular-hastate with a pair of wide-based, obtuse lobes pointing outward, 2-9 cm long, 2-7 cm broad, the apex acute to obtuse or rounded, mucronate, base cordate, truncate or rarely somewhat obtuse, often with a pair of simple or compound teeth toward the outer margin, entire, broadly serrate, dentate or irregularly toothed, green or reddish, the upper leaves smaller and less toothed (or hastate); **petioles** 1-3 (-4) cm long;

stems erect, decumbent or procumbent, subangular to angular, green or green-and stramineous-striped, reddish or not, 1-10 dm tall, little-branched to much-branched, the branches opposite or subopposite, ascending to procumbent, 1-5 dm long; **root system** annual with a taproot.

Note: A species often confused with *A. patula*; however, the broad, truncate leaf bases and broadly ovate bracteoles with spongy layers are distinctive characters of this taxon.

Importance: The seeds of *Atriplex patula* were used much like those of Garden Orach, and were said to cure yellow jaundice. The leaves have, occasionally, been eaten as a potherb.

Waifs: *Atriplex argentea* Nutt. and *A. serenana* A. Nels. were both collected once in Tompkins county on a newly seeded lawn. *Atriplex laciniata* L. has been reported from New York City but no specimens have been seen.

3. SPINACIA

Common Name: Spinach

Authority: Linnaeus, Species Pl. II, p. 1027, 1753

A genus of 3 species, from southwest Asia.

Waif: *Spinacia oleracea* L., garden spinach, has been collected in Albany, Madison, Monroe, New York, Suffolk, Tompkins & Yates Counties as a non-persistent escape from cultivation.

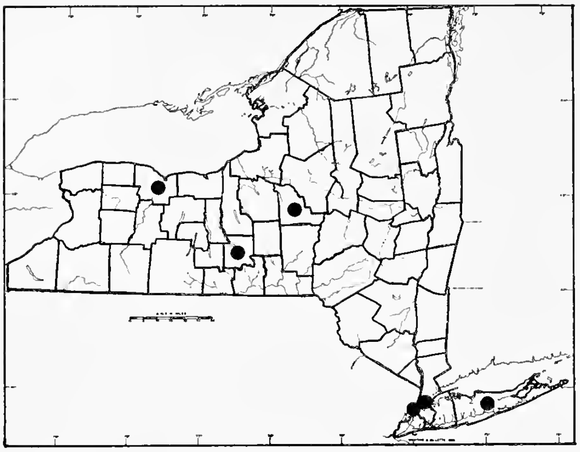
Importance: Spinach has long been cultivated for its succulent, edible leaves. The leaves are rich in Vitamins A, B, C and chlorophyll, and their high iron content has caused them to be recommended for persons suffering from anemia.

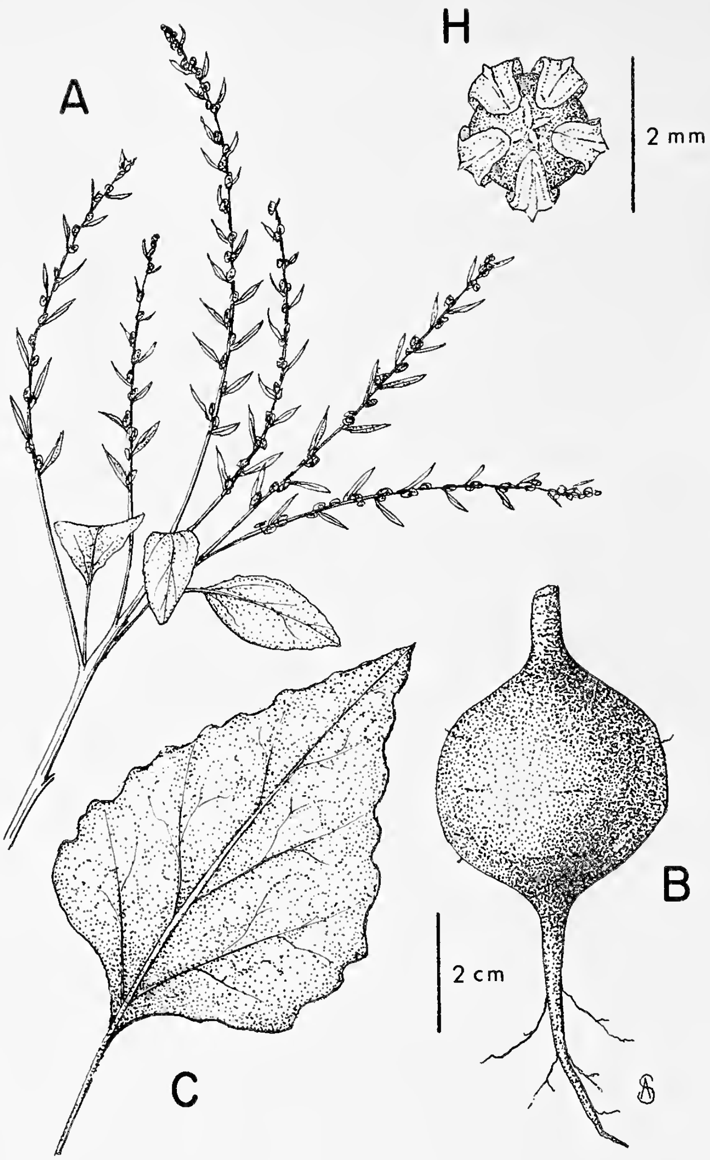
4. BETA

Common Name: Beet

Authority: Linnaeus, Species Pl. I, p. 222, 1753

A genus of 6-12 species, native to the Mediterranean Region. Cultivated varieties of the garden beet escape, and plants of the wild-growing, European subspecies have been reported in North America as ballast waifs.





1. ***Beta vulgaris*** **L.**

Common Names: Garden Beet, Beetroot, Mangel Wurzel, Swiss Chard, (Seaside Beet)

Type Description: Linnaeus, Species Pl. I, p. 222, 1753

Origin: A native of Europe

Habitats: Waste places, especially in coastal areas and around vegetable gardens

Habit: Erect or prostrate, annual herbs

Flowering: August

Fruiting: September

General Distribution: Coastal Europe; in North America widely scattered but hardly naturalized, occurring as a garden escape or waif, especially in coastal areas from New York to British Columbia

Description: Plants with **bisexual** flowers; **stigmas** 2-3, oblong to triangular, spreading, 0.6-0.7 mm long; **style** absent; **ovary** 1, partially inferior, depressed obovoid, unilocular, with a single basal **ovule**; **fruit** an indehiscent utricle, depressed-ovoid, the pericarp attached to the perianth below, above fleshy or indurate, non-adherent, 0.7-1.6 mm long, 1.3-2.5 mm broad; **seed** 1, homomorphic, horizontal, black, orbicular to reniform, 1.5-2.0 mm in diameter, 1.2-1.5 mm thick, testa smooth, glabrous; **embryo** annular; **perisperm** copious; **radicle** centrifugal; **stamens** 5, perigynous; **filaments** linear, membranaceous, 0.9-1.0 mm long; **anthers** tetrasporangiate, globose, yellow, 0.5-0.6 mm long; **perianth** 5-lobed, urceolate; **lobes** adherent to the base of the ovary and to others of the same glomerules, herbaceous to coriaceous, oblong, becoming linear, 0.9-1.3 mm long, 0.5-0.9 mm broad, apex obtuse, strongly carinate forming a hood; **bracts** linear to linear-lanceolate, 1.0-1.3 cm long, 0.5-5 mm broad, often absent from the upper part of the inflorescence; **pedicels** very short, the flowers forming glomerules; **bracteoles** absent; **inflorescence** terminal, of simple or paniculate spikes and axillary glomerules, in dense spikes at first, these becoming much-elongated and interrupted in fruit; **glomerules** 1-8 flowered, sessile, the flowers often connivent in fruit due to the swollen perianth and receptacle; **leaves** simple, alternate and basal, herbaceous, basal leaves oval or ovate-oblong, 13-18 (-70) cm long, 4-15 cm broad, apex rounded or obtuse, the base subcordate and abruptly decurrent, entire or subsinuate, often undulate, fleshy, green to dark red or purple, the blades of the cauline leaves broadly ovate to lanceolate, acute to acuminate; **petioles** of basal leaves often as long as the blades, the cauline leaves subsessile; **stems** herbaceous, 6-12 (-20) dm tall, 1-several from each root, erect or procumbent, usually glabrous throughout; **root system** annual or biennial (perennial), branched and somewhat woody, showing rings of growth in cross-section, the cultivated beets developing a swollen taproot, conic to broadly depressed-fusiform, white, or often with yellow to dark red-purple pigmentation, up to 15 (-35) cm long and 18 cm in diameter (2n = 18).

Infraspecific Variation: Two subspecies have been collected in New York State. *Beta vulgaris* ssp. *vulgaris* (the garden beet) has an unbranched greatly swollen root that is often top-shaped, erect stems and glomerules with 1-8 flowers that cling together. *Beta vulgaris* ssp. *maritima* (L.) Arcang. usually has a branched, non-swollen root, procumbent stems and glomerules of mostly 1-2 flowers that are not strongly coherent.

Importance: *Beta vulgaris* is unique among cultivated plants. It has been brought into cultivation four separate times for four different uses. The most common cultivar is the garden beet, the root of which is usually boiled or pickled. The red-purple juice is a notoriously difficult stain to remove from clothing, and it has been used as a dye for both food and apparel. Swiss chard has been selected for its leaves that are edible as salad greens or boiled like spinach. The foliage of most beets is very high in calcium oxalate content and can numb the palate or even result in oxalate poisoning if too much of the substance is ingested. The sugar beet has been selected for its high sucrose content, and it serves as a major source of refined sugar. Cultivated forms often have up to 13 percent sugar. The crop called Mangels Wurtzel has been selected for roots that are high in nutritive value, making them ideal for use as livestock fodder. There are also a number of cultivars of beet and chard that are grown for their colorful foliage.

5. SALSOLA

Common Names: Russian Thistle, Salsola, Tumbleweed

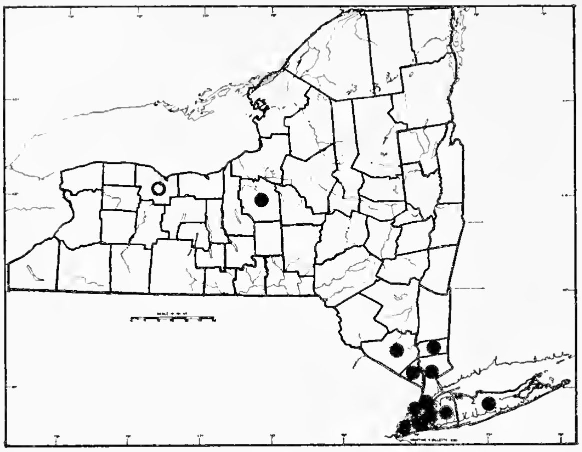
Authority: Linnaeus, Species Pl. I, p. 222, 1753

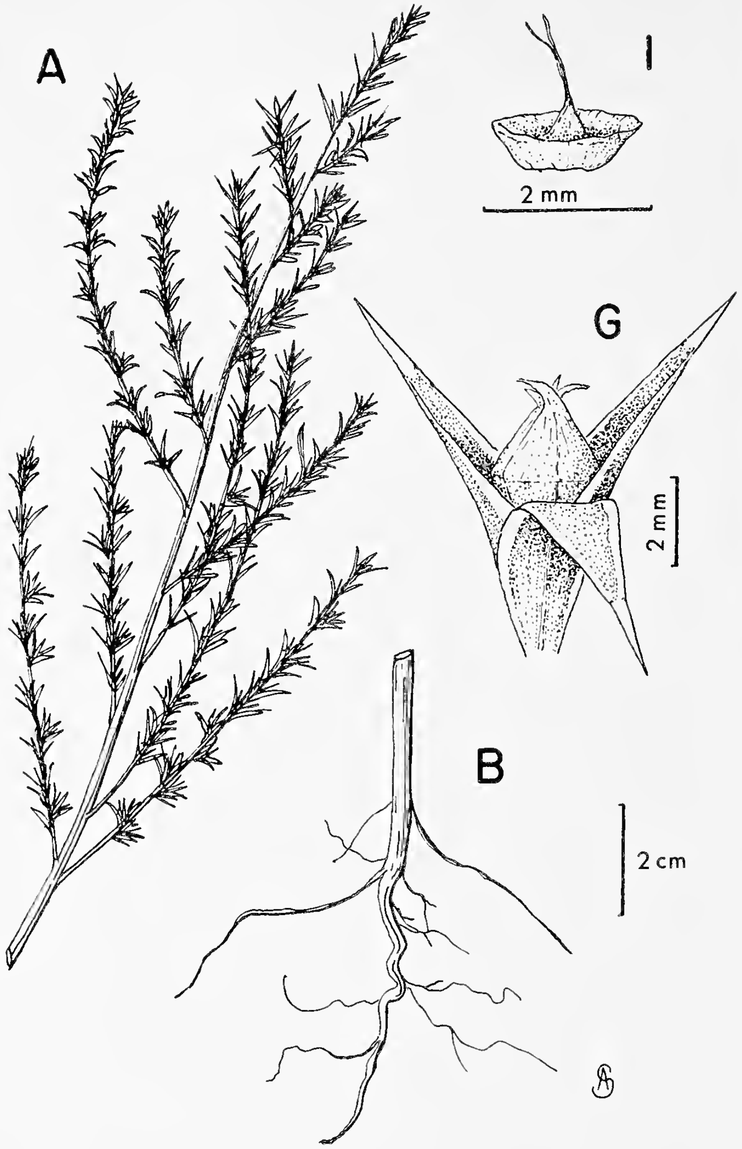
A genus of 120-150 species: cosmopolitan but most diverse in the Asia. *Salsola* grows mostly along sea-coasts and in other saline or alkaline habitats. Many species have been used for extracting potash.

Description: Plants with **bisexual** flowers; **stigmas** 2 (-3), subulate; **style** 1 or absent; **ovary** 1, superior, unilocular with a single, basal **ovule**; **fruit** a dehiscent or indehiscent utricle, included in the perianth, the pericarp fleshy or membranaceous, non-adherent; **seed** 1, horizontal, rarely inverted, erect or oblique; **embryo** spiral or cochleate-spiral; **perisperm** absent; **radicle** centrifugal; **stamens** 5 or fewer, hypogynous or rarely inserted on a minute disk; **filaments** linear; **anthers** tetrasporangiate; **perianth** deeply 5-lobed (rarely 4-lobed), incurved over the fruit at maturity, the tips connivent and erect, transversely carinate or winged; **bract** narrowly triangular, the apex spinose; **pedicels** very short, the flowers subsessile; **bracteoles** 2, narrowly triangular, apex spinose; **inflorescences** are terminal spikes with solitary flowers, or fascicles in the axils of leaf-like bracts; **leaves** simple, usually alternate, succulent, sessile or clasping; **petioles** absent; **stems** herbaceous or woody, glabrous or pubescent; **root system** an annual taproot or perennial stalk.

KEY TO SPECIES

1. Sepals stiff, somewhat spinose, with a distinct mid-vein and a very small or absent wing; plants usually hispid; early leaves linear to lanceolate .... 1. *S. kali*
1. Sepals soft with an obscure midvein and prominent, broad wings; plants often glabrous; early leaves long, linear, filamentous .... 2. *S. pestifer*





1. *Salsola kali* L.

Common Names: Russian Thistle, Salsola, Barilla

Type Description: Linnaeus, Species Pl. I, p. 222, 1753

Synonym: *Salsola kali* var. *caroliniana* (Walt.) Nutt.

Origin: Native to Eurasia

Habitats: Sea beaches and in sandy soil near the coast

Habit: Erect, annual herb

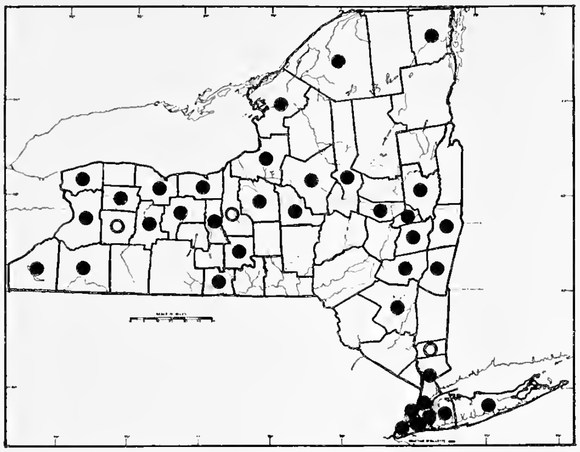
Flowering: July-September

Fruiting: September-November

General Distribution: Native to eastern Europe and western Asia (Russia), now widespread in North America: Newfoundland to Georgia, especially along the coast

Description: Plants with **bisexual** flowers; **stigmas** 2, erect, 1.2-1.5 mm long; **style** 0.4-0.6 mm long; **ovary** obovoid; **fruit** obconic, closely investing the seed and nearly the same size; **seed** black, orbicular, 1.4-2.0 mm tall, 2-3 mm wide; **stamens** usually 5; **filaments** membranaceous, 1.4-2.0 mm long; **anthers** elliptic, yellow, 0.4-0.9 mm long; **perianth** 3-6 mm wide, rarely with short transverse wings in age; **lobes** scarious becoming hardened in fruit, lanceolate, 2.0-2.4 mm long, 1.2-2.0 mm broad, pungent; **bracts** 5-8 mm long, 1.5-4.0 mm broad, their bases (in age) much thickened, indurate and closely enclosing the fruit; **bracteoles** like the bracts but smaller; **inflorescence** of terminal spikes, 8-15 cm long, 13-20 mm broad, with 2-3 flowers at each node, of which only the lowermost develops; **leaves** linear, 3-7 cm long, 1.5-2.5 mm wide, pungent-tipped, thick and succulent, scabrous or glabrous; **stems** 3-6 (-10) dm tall, much-branched, the branches very stout, ascending or spreading, hispid, glabrate, sometimes glabrous, striate, commonly tinged with red; **root system** annual with a tap-root (2n = 36).

Importance: Young shoots are sometimes eaten as a pot herb. The plant was once burned and the ashes used in making soap and glass. The juice of the fresh plant has been said to be an excellent diuretic.



2. *Salsola pestifer* A. Nelson

Common Name: Russian Thistle

Type Description: R. Brown, Prodr. Fl. Nov. Holland p. 411, 1810

Synonyms: *Salsola iberica* Sennen & Pau, *S. kali* var. *ruthenica* (Iljin) Soó in Soó and Jvorka, *S. kali* var. *tenuifolia* Tausch. not Mey., *S. ruthenica* Iljin, *S. tragus* of NY reports, not L.

Origin: A native of Northern Eurasia

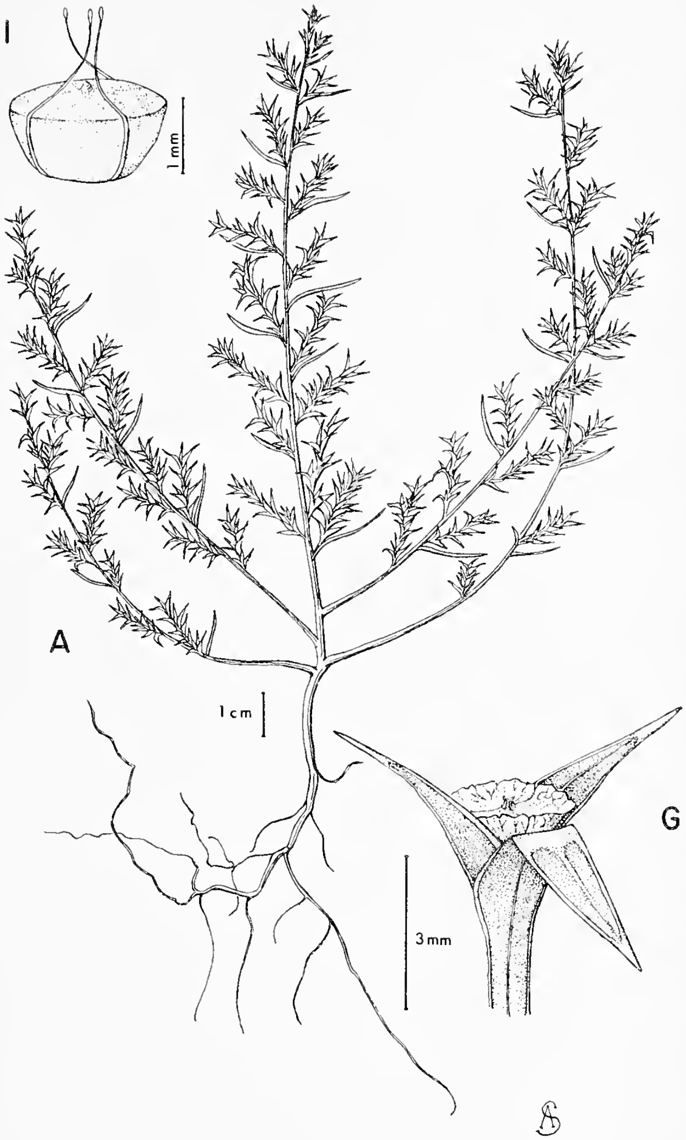
Habitats: Cultivated fields and waste places, especially along railroads and where the soil is sandy

Habit: Erect, annual herb

Flowering: July-September

Fruiting: September-November

General Distribution: Southern Europe and Russia, now widespread throughout the world; in North America from Quebec to British Columbia south to Missouri and New York



Description: Plants with **bisexual** flowers; **stigmas** 2, erect with curling tips, 1.0-1.4 mm long; **style** 0.4-0.5 mm long; **ovary** obovoid; **fruit** obconic, closely investing the seed and nearly the same size; **seed** black, obconic, 1.5-2.0 mm long, 2-3 mm wide; **stamens** usually 5; **filaments** membranaceous, 1.8-2.5 mm long; **anthers** elliptic, yellow, 0.5-1.2 mm long; **perianth** 6-10 mm wide (including wings), transversely winged in age, the wings thin, crenate or dentate, conspicuously veined, often tinged with red, the perianth of the lower axil often merely carinate or with short thick wings; **lobes** (in flower) membranaceous, lanceolate, 1.5-1.7 mm long, 1.1-1.8 mm broad, apex acuminate, the lower portion becoming hardened and laterally winged in fruit, the upper portion remaining membranaceous; **bracts** narrowly lanceolate, broad-based, 0.5-1.5 cm long, 1.5-2.5 mm broad, closely enclosing the fruit, not connivent; **bracteoles** similar to the bracts but smaller; **inflorescence** of terminal and axillary spikes 1-6 cm long, 10-18 mm broad, with 2-3 flowers at each node, of which only the lowermost develops; **leaves** filiform, 1.2-4.5 cm long, 0.4-0.6 mm wide, pungent-tipped, subterete and succulent, scabrous or glabrous; **stems** 3-6 (-10) dm tall, much-branched, the branches very stout, ascending or spreading, short-villous or scabrous, sometimes nearly or quite glabrous, striate, commonly tinged with red; **root system** annual with a taproot (2n = 36).

Nomenclatural Note: This species is, occasionally, known under the name *S. australis* R. Br. (see, for example, Botschantzev, 1974), but Crompton (pers. comm.) has seen the type of *S. australis* and determined it to be *S. kali*; therefore, the earliest name for this species is *S. pestifer*.

6. SUAEDA

Common Name: Sea-blite

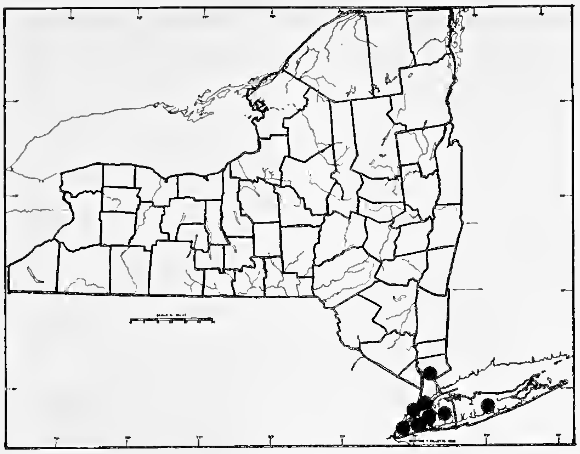
Authority: Forsskål, Fl. Aegypt. Arab. p. 69, 1775

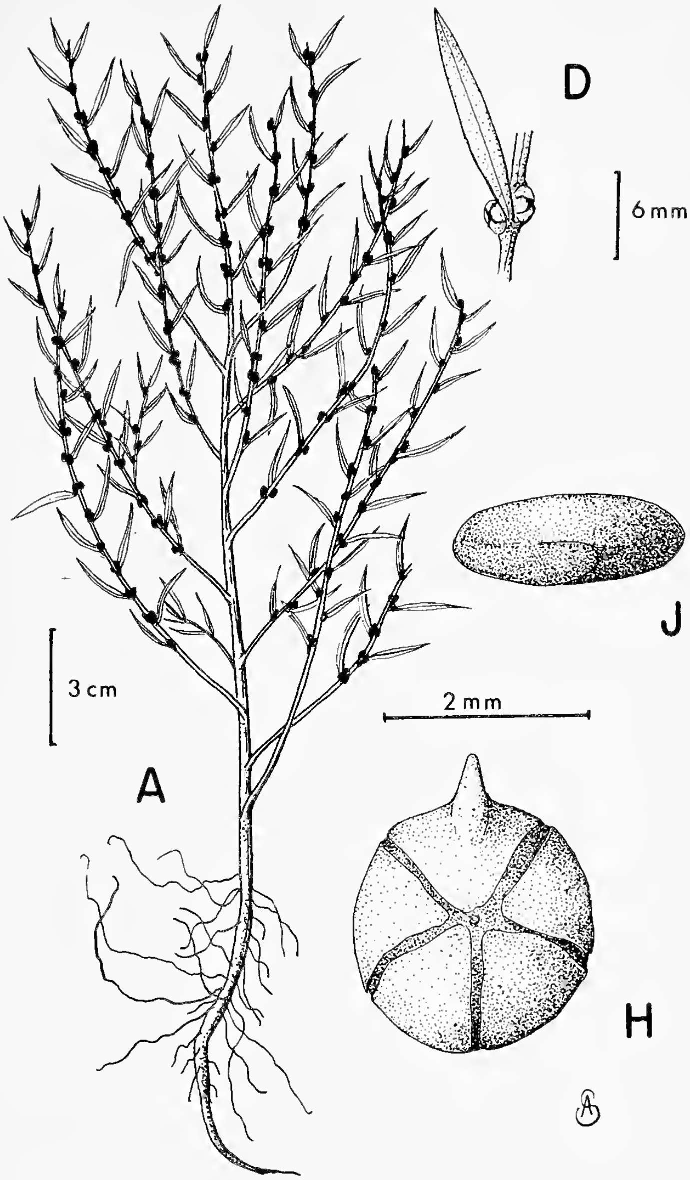
A genus of about 100 species of cosmopolitan distribution, except in boreal climates, and most diverse in the Middle East. Nearly all species of the genus are halophytes, found in salt marshes, salt lakes and other saline or alkaline habitats.

Description: Plants with **bisexual** flowers, or **monoecious** or **dioecious**; **stigmas** 2-5, filiform; **style** absent; **ovary** 1, superior, unilocular, with a single basal **ovule**; **fruit** an indehiscent utricle enclosed by the infolded perianth, and closely enveloping the seed, the pericarp membranaceous, usually non-adherent; **seed** 1, homomorphic, horizontal or vertical, lenticular; **embryo** coiled in a flat spiral; **perisperm** scanty or none; **radicle** centrifugal; **stamens** 5, hypogynous; **filaments** linear, distinct; **anthers** tetrasporangiate; **perianth** 5-lobed; **bracts** leaf-like, subtending the glomerules; **bracteoles** 2, scarious; **inflorescences** small irregular glomerules in axil of leaves; **leaves** simple, alternate, mostly succulent, narrow and often terete, never spine-tipped; **stems** more or less fleshy-herbaceous (or suffrutescent), glabrous to short-pubescent, from an **annual** taproot or **perennial** rootstalk.

KEY TO SPECIES

1. Mature seeds 1.0-1.5 mm diameter; sepals corniculate or carinate ....(2)
1. Mature seeds 1.5-2.0 mm diameter; sepals rounded or carinate ....(3)
   2. Sepals unequal, 1 or 2 corniculate, the others slightly keeled ....1. *S. calceoliformis*
   2. Sepals equally carinate ....2. *S. linearis*
3. Sepals rounded on abaxial surfaces ....3. *S. maritima*
3. Sepals carinate abaxially ....4. *S. rolandii*





1. *Suaeda calceoliformis* (Hook.) Moq.

Common Names: Matted Sea-blight, American Seepweed

Type Description: Hooker, Fl. Bor. Amer. 2: 126, 1838

Synonyms: *Chenopodium calceoliforme* Hook., *Dondia americana* (Pers.) Britton, *Salsola americana* (Pers.) Fern., *S. salsa* var. *americana* Pers.

Origin: A native of western North America and the boreal northeast

Habitats: Salt marshes (coastal in New York)

Habit: A prostrate to decumbent, occasionally erect, annual herb

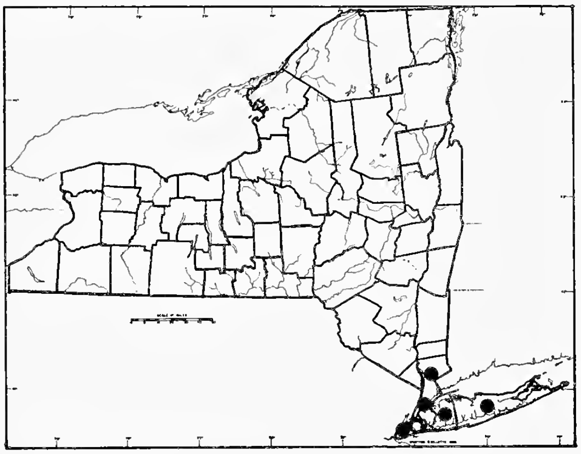
Flowering: August-October

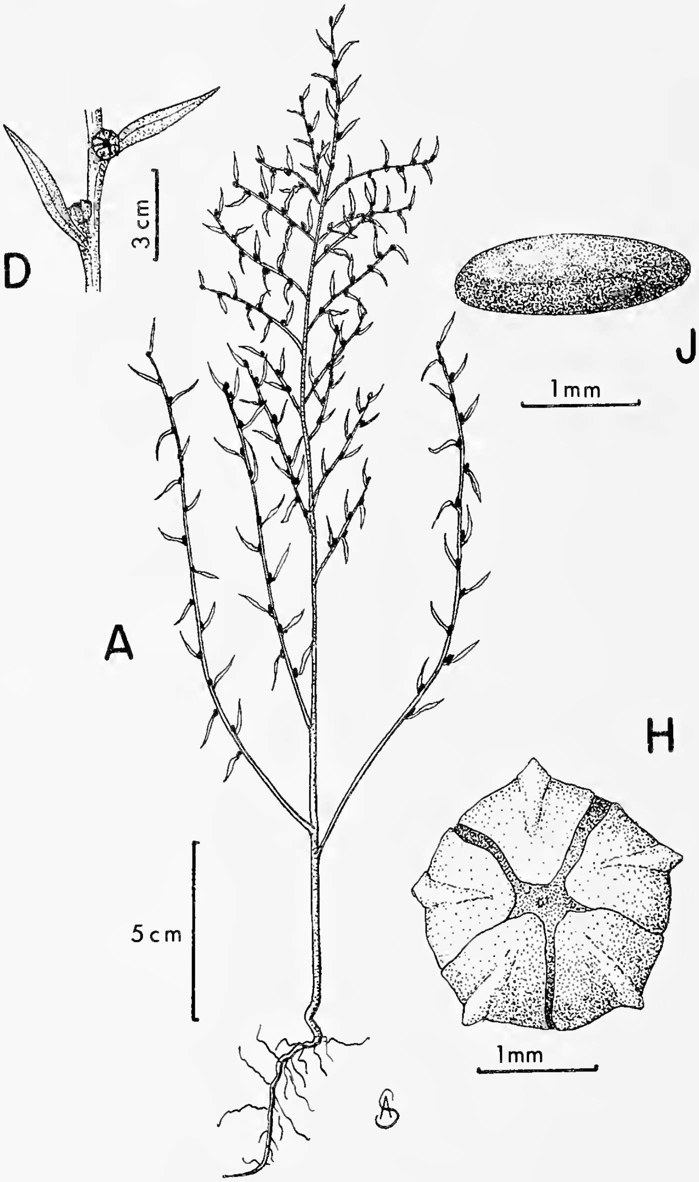
Fruiting: September-November

General Distribution: Newfoundland to the Northwest Territories south to California, Texas, Michigan and New Jersey

Description: Plants with **bisexual** flowers (or some unisexual by abortion); **stigmas** 2, erect or spreading, 0.1-0.2 mm long; **ovary** depressed-ovoid; **fruit** depressed-ovoid or ellipsoid, pericarp non-adherent, closely investing the seed, the fruit therefore nearly the same size as the seed; **seed** horizontal, dark red when young, black when mature, ovoid to ellipsoid, 1.0-1.5 (-1.7) mm in diameter, 0.5-0.7 mm thick, testa verrucate under high magnification; **stamens** 5; **filaments** membranaceous, 0.5-0.6 mm long; **anthers** oblong, yellow, 0.3-0.4 mm long; **perianth** 1.4-1.8 (-2) mm wide; **lobes** membranaceous, irregular and unequal, ovate to deltate, 0.5-0.8 mm long, 0.4-0.8 mm broad, one or two of the sepals usually more strongly hooded and corniculate than the others, horn 0.3-0.4 mm long, with a transverse wing occasionally developed at the base; **bract** linear, 2-10 mm long, 0.8-1.5 mm broad; **inflorescences** terminal on lateral branches, subspicate, the flowers crowded in the axils of reduced leaves, some flowers also in the axils of lateral branches; **glomerules** 1.5-2.5 mm in diameter; **leaves** linear, mostly semiterete, rarely flat, apex acute, margins entire, fleshy or succulent, green, occasionally becoming red or purple, lower leaves (0.5-) 1-4 cm long, 0.2-1.0 mm wide, shorter and broader (to 1.5 mm wide) in the inflorescence; **stems** prostrate or decumbent, occasionally erect, 20-65 cm tall, branches 1 to many, 19-31 cm long, spreading ascending to horizontal, the abundant flowering branches ascending or occasionally erect, mostly from the base of the plant, the lowermost sometimes opposite, stems rounded, mostly brownish green and slightly woody at the base, glabrous; **root system** annual with a woody taproot up to 50 cm long (2n = 54).

Nomenclatural Note: Atlantic coastal plants have, usually, been treated under the name *S. americana*, but Bassett & Crompton (1978b) have combined the eastern taxon with the widespread western taxon *S. calceoliformis* (often treated under the name *S. depressa*). I agree that the eastern plants fall within the range of variation of the western species.





2. *Suaeda linearis* (Ell.) Moq.

Common Name: Southern Sea-blite

Type Description: Elliott, Bot. S. C. & Ga. vol. 1, p. 332, 1821

Synonym: *Dondia linearis* (Ell.) Heller

Origin: Native to the Atlantic Coast of North America

Habitats: Salt marshes and sea beaches primarily along the coast

Habit: Erect, annual herb

Flowering: August-September

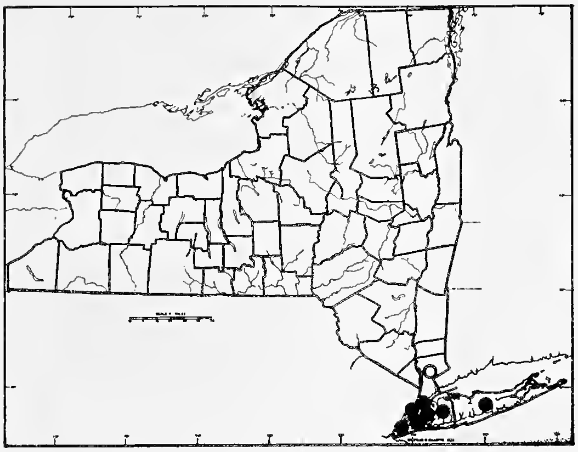
Fruiting: September-October

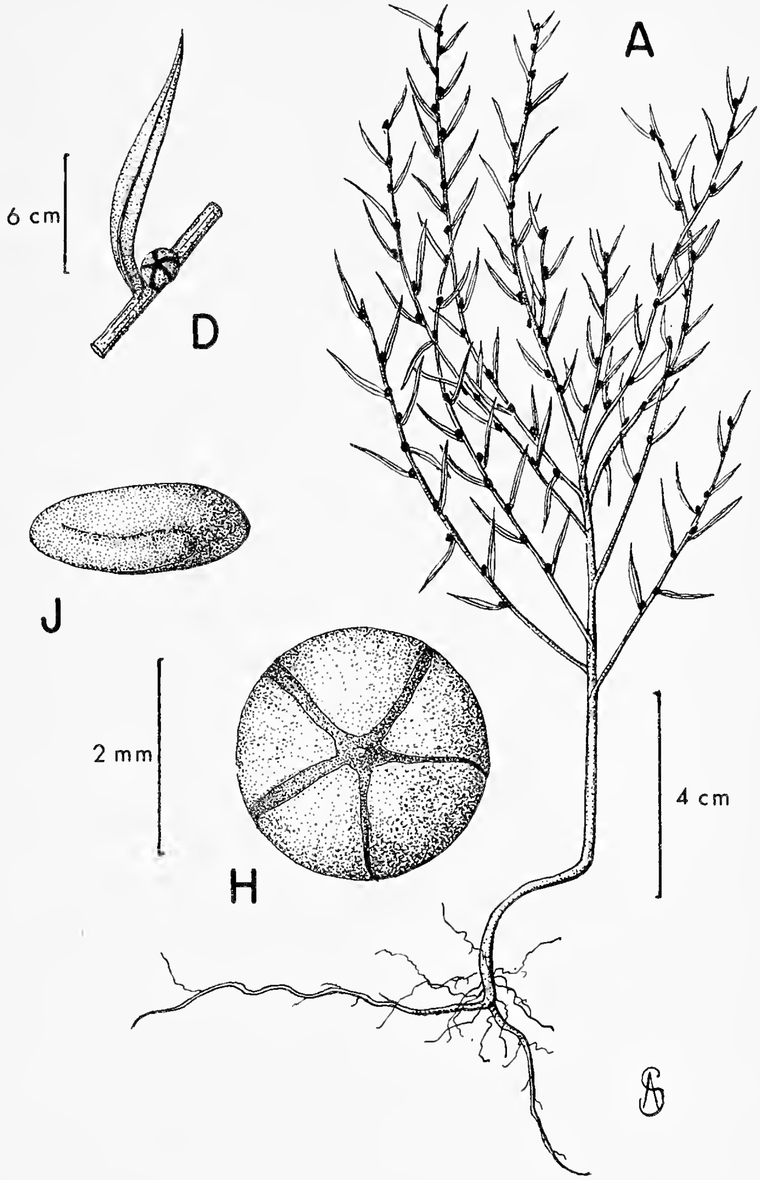
General Distribution: The Atlantic Coast of North America, from New York to the Yucatan Peninsula, Mexico and the West Indies

Rarity Status: This species is ranked G5 S3? by the New York Natural Heritage Program, and it appears on their watch list.

Description: Plants with **bisexual** flowers (or some unisexual by abortion); **stigmas** 2 (-5), spreading, 0.1-0.2 mm long; **ovary** depressed-ovoid; **fruit** depressed-ovoid, pericarp non-adherent, closely investing the seed and nearly the same size; **seed** horizontal, ovoid, black, 1.0-1.5 mm in diameter, 0.6-0.8 mm thick, the testa minutely reticulate; **stamens** 5; **filaments** membranaceous, 0.6-0.9 mm long; **anthers** oblong, yellow, ca. 0.2 mm long; **perianth** 1.5-2.0 mm wide; **lobes** membranaceous, broadly ovate to deltate, 0.5-0.6 mm long, 0.7-1.1 mm broad, equally carinate, apex obtuse; **bract** linear, 2-7 mm long, 0.7-1.1 mm broad; **inflorescences** terminal and axillary, spikes, 4-12 cm long, 2-4 mm broad, some glomerules in the axil of branches; **glomerules** 1-3 flowered, 2-4 mm in diameter; **leaves** narrowly linear, semiterete, apex acute, dark green, not glaucous, 0.7-1.5 (2.5) cm long, 3-5 mm wide, shorter in the slender elongated flowering branches; **stems** erect to ascending or decumbent, 2-9 dm tall, profusely branched, the slender branches ascending or spreading; **root system** annual, a taproot, sometimes persisting in warm regions.

Note: The similar species *Suaeda richii* Fern., with a non-keeled calyx, should be sought out in New York, since it is found in both Massachusetts and New Jersey. No specimens of that species from the State have been seen to date.





3. *Suaeda maritima* (L.) Dumort.

Common Name: White Sea-blite

Type Description: Linnaeus, Species Pl. I, p. 221, 1753

Synonyms: *Chenopodium maritimum* L., *Dondia maritima* (L.) Druce, *D. fernaldii* Standley, *Suaeda fernaldii* Standley

Origin: A native of Europe

Habitats: Coastal marshes

Habit: Growing mostly in wet salt marshes, high, tidal beaches and coastal mud flats

Flowering: August-September

Fruiting: September-November

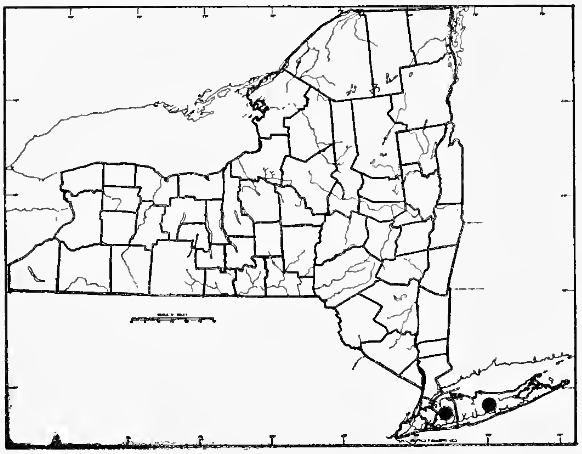
General Distribution: Coastal Europe: introduced in North America along the Atlantic Coast from Quebec to Florida and also reported from the Pacific Coast

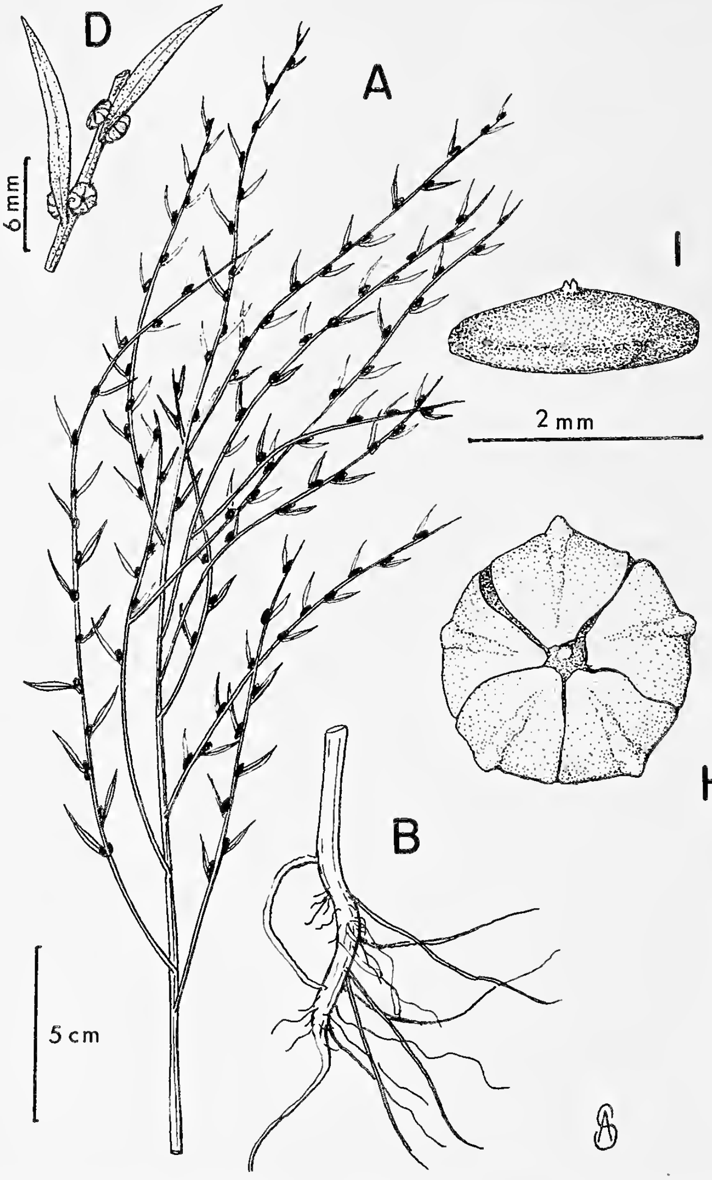
Rarity Status: This species is ranked G5 S3 by the New York Natural Heritage Program and has been placed on their watchlist.

Description: Plants with **bisexual** flowers (or some unisexual by abortion); **stigmas** 2-3 (-5), erect or spreading, 0.5-0.7 mm long; **ovary** depressed-ovoid; **fruit** depressed-ovoid, pericarp non-adherent, closely investing the seed and nearly the same size; **seed** horizontal, red-brown to black, ovoid, (1.5-) 1.8-2.2 mm in diameter, 0.7-0.9 mm thick, testa faintly reticulate; **stamens** 5; **filaments** membranaceous, 1.0-1.7 mm long; **anthers** oblong, yellow, 0.4-0.5 mm long; **perianth** 2.0-3.3 mm wide; **lobes** membranaceous, broadly ovate to deltate, 1.5-1.7 mm long, 0.7-1.0 mm broad, pale green, rounded or obscurely carinate on back, occasionally hooded or keeled at maturity, the apex rounded to obtuse; **bracts** oblong, 0.5-0.7 mm long; **inflorescences** of glomerules in the axils of leaves; **glomerules** subglobose, 1-3 (-4) flowered, 3-5 mm in diameter; **leaves** linear, mostly subterete, occasionally flat, ascending or spreading, fleshy to succulent, the apex acute, margins entire, glaucous, dark green, 0.5-4.0 (-5) cm long, 0.8-1.7 mm wide, the leaf base only slightly, if at all, wider than the rest of the blade; **stems** erect to ascending, decumbent or prostrate, terete, mostly light brown, and slightly woody at the base, plants 0.5-6 dm tall, profusely branched, the slender branches ascending to spreading or decumbent, mostly from the lower parts of the plant; **root system** a slightly woody taproot, annual, but sometimes persisting in warmer regions (2n = 36).

Variation: This is a highly variable species, but all of our specimens are the typical var. *maritima*.

Importance: This species is used for potash extraction in Europe and Asia. The fresh plant has laxative properties that disappear on boiling.





4. *Suaeda rolandii* Bassett & Crompton

Common Name: Sea-blite

Type Description: Bassett & Crompton, Can. Jour. Bot., vol. 56, p. 588, 1978

Origin: A native of the coasts of northeastern North America

Habitats: Salt marshes

Habit: Erect or procumbent, annual herb

Flowering: August-September

Fruiting: September-October

General Distribution: Nova Scotia to Quebec south to New Jersey along the coast

Rarity Status: This species is very rare throughout its range, and it has been proposed as a Federally Endangered species, currently ranked G1G2Q SH by the New York Natural Heritage Program.

Description: Plants with **bisexual** flowers (or some unisexual by abortion); **stigmas** 2-3, erect or spreading, ca. 0.2 mm long; **ovary** depressed-ovoid; **fruit** depressed-ovoid, pericarp non-adherent except on the more flattened fruits, where it is adherent, closely investing the seed and nearly the same size; **seed** horizontal, dimorphic, black or reddish brown, the more flattened, brown seeds developing later in the season, 1.5-2.3 mm in diameter, 0.5-0.7 mm thick, testa of the black and reddish-brown seeds shiny and finely reticulate, whereas the flattened, brown seeds are dull with no distinctive surface pattern; **stamens** 2-5; **filaments** membranaceous, ca. 1 mm long; **anthers** oblong, white, ca. 0.2 mm long; **perianth** ca. 3.5 mm in diameter; **lobes** membranaceous, ovoid, ca. 1 mm long, 1.0-1.5 mm broad, hooded and keeled abaxially, the apex rounded; **bracts** oblong, 0.4-1.2 mm long; **inflorescences** of glomerules in the axils of leaves; **glomerules** subglobose, 1- to 3-flowered, 4-5 mm in diameter; **leaves** linear, mostly subterete, occasionally flat, ascending or spreading, very fleshy and succulent, the apex acute, margins entire, glaucous, dark-green, 1.7-2.5 (-3) cm long, 0.7-1.5 mm wide, the base of leaf not wider than the rest of the blade, becoming bract-like and shorter towards the inflorescence; **stems** erect or procumbent, the plants 2-7 dm tall, branches 1-several, ascending or erect, mainly from the uppermost part of the plant, stems rounded, light brownish-green, becoming woody at the base near maturity; **root system** annual with a woody taproot (2n = 90).

Note: This species is apparently allotetraploid in origin, derived from *S. calceoliformis* and *S. maritima*.

7. BASSIA

Common Names: Bassia, Summer-cypress (Kochia)

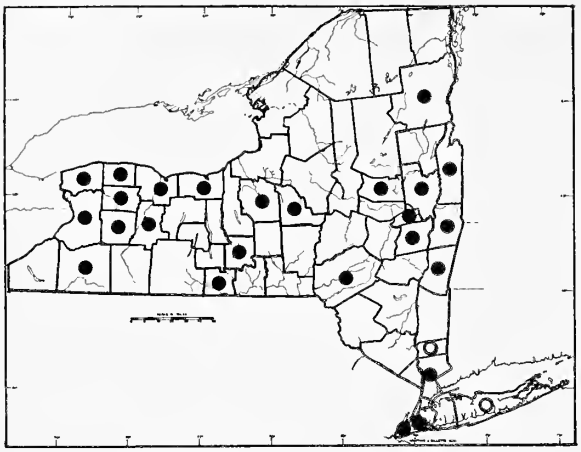
Authority: Allioni, Mélanges Philos. Math. Soc. Roy. Turin, vol. 3, p. 177, 1766

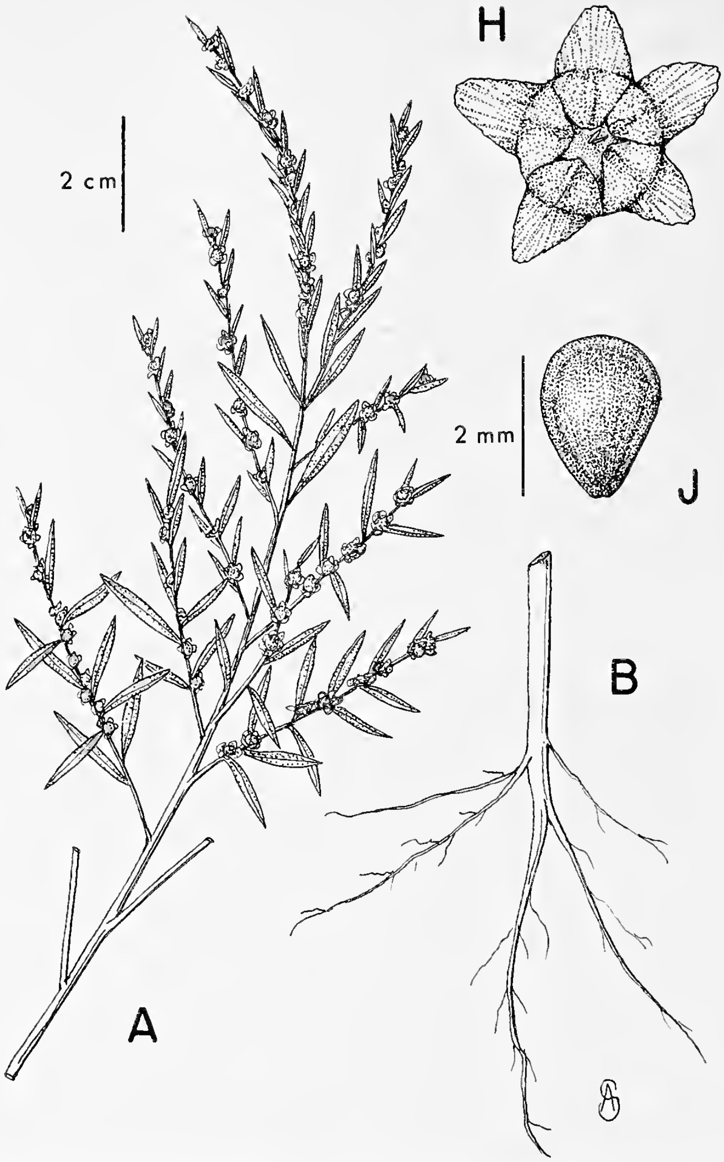
A genus of about 30 species, when recognized in the broad sense. *Kochia* is nearly cosmopolitan in distribution. Scott (1978a) combined *Kochia* and *Bassia*, citing the only difference between the two genera as the nature of the calyx in fruit. *Kochia* has a winged fruiting calyx, whereas *Bassia* has no wings, but it may have spines or other protuberances. Scott also noted that some *Kochia* species have spines with wings developed between them. The following treatment follows Scott in combining the two genera.

Description: Plants with all **bisexual** flowers or **polygamous**; **stigmas** 2 (-3), filiform; **style** 1 or absent; **ovary** 1, superior, unilocular with a single basal **ovule**; **fruit** an indehiscent utricle, enclosed in the accrescent perianth, pericarp membranaceous, non-adherent; **seed** 1, homomorphic, horizontal, rarely vertical in a few bisexual flowers; **embryo** annular or subannular; **perisperm** abundant, farinaceous, or absent; **radicle** centrifugal; **stamens** 5, hypogynous; **filaments** linear, distinct; **anthers** tetrasporangiate; **perianth** 5-lobed, connate to above the middle with reflexed lobes, becoming accrescent, chartaceous in fruit, with horizontal wings, spines, lobes or without appendages; **bracts** linear; **bracteoles** absent; **inflorescences** of terminal spikes of single or paired flowers, or rarely glomerules at the nodes; **leaves** simple, alternate, herbaceous or succulent; **petioles** very short or absent; **stems** herbaceous, with an **annual** taproot or **perennial** root system.

KEY TO SPECIES

1. Fruiting perianth winged .... 1. *B. scoparia*
1. Fruiting perianth with spines or tubercles .... (2)
    2. Leaves linear to filiform; fruiting perianth with short, connate tubercles .... 2. *B. hirsuta*
    2. Leaves oblanceolate; fruiting perianth with long, curled spines .... [*B. hyssopifolia*, a waif]





1. *Bassia scoparia* (L.) A. J. Scott

Common Names: Summer-cypress, Belvedere-cypress, Fire-weed, Kochia, Mock-cypress, Mexican fire-bush

Type Description: Linnaeus, Species Pl. I, p. 221, 1753

Synonyms: *Kochia alata* Bates, *K. scoparia* (L.) Roth ex Schrad.

Origin: Native to Asia and southern Europe

Habitats: Waste places

Habit: Erect, annual herbs

Flowering: Late July-September

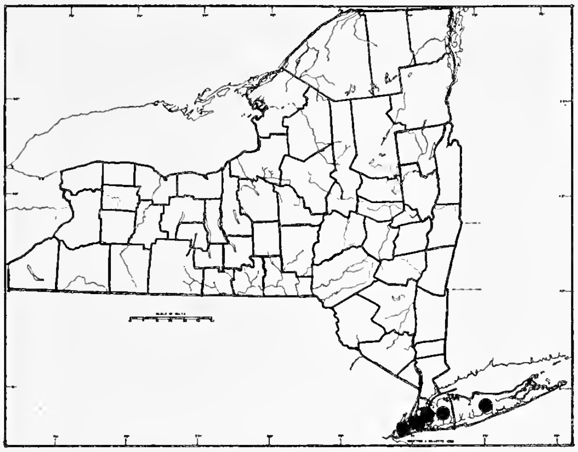
Fruiting: Late August-October

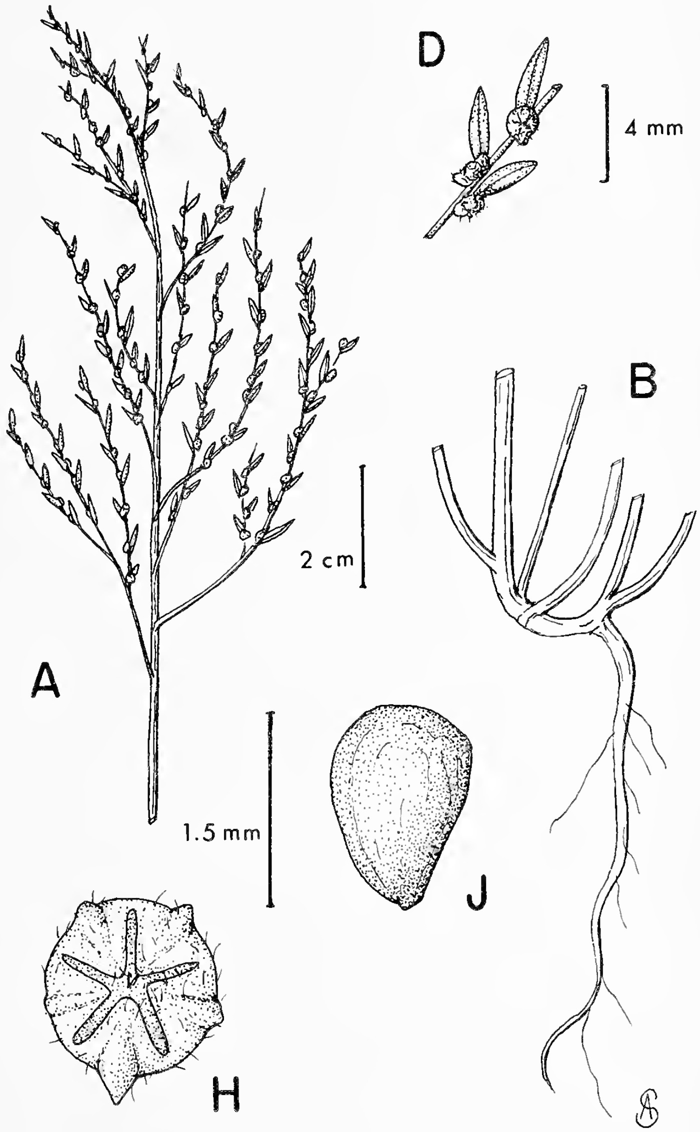
General Distribution: Native to Eurasia; naturalized in North America from Nova Scotia to British columbia south to Colorado, Texas and Pennsylvania

Description: Plants with **bisexual** flowers (sometimes functionally unisexual); **stigmas** 2 (-3), erect or spreading, 1-2 mm long; **style** 0.2-0.3 mm long; **ovary** depressed-ovoid; **fruit** depressed-ovoid, 1.4-1.6 mm long, 0.9-1.2 mm broad, the pericarp free, eventually disintegrating; **seed** horizontal, brown to black, obovoid, 1.4-1.6 mm in long, 0.9-1.2 mm broad, 0.4-0.6 mm thick, testa smooth or glandular; **stamens** 5; **filaments** membranaceous, 1.0-1.3 mm long; **anthers** ellipsoid, light yellow, ca. 0.5 mm long; **perianth** 2-4 mm in diameter at maturity, star-shaped; **lobes** triangular, 0.4-0.5 mm long, 0.5-0.6 (-1.5) mm broad, in fruit accrescent, chartaceous, each lobe bearing a highly variable membranaceous dorsal lobe or wing, varying from short and tubercle-like to usually flat, oblong-rotund or rotund, semi-membranaceous, cellular reticulate, often striate, entire, lobed or bifid, lobes or wings 0.4-0.7 (-1) mm long and 0.7-1.5 mm broad; **bracts** linear, 3-18 mm long; **inflorescences** terminal spikes, 3-10 cm long, or flowers spaced along the branches in the axils of leaves, the flowers sessile, usually paired, sometimes single, rarely in 3-5 flowered glomerules, the flowers enclosed by tufts of short or long hairs; **leaves** thin, linear to lanceolate or oblanceolate to narrowly obovate, 2-7 (-10) cm long, 0.5-8.0 (-12) mm broad, apex acute or obtuse to rounded, tapering to the base, entire, ciliate, usually villous or pilose, with hairs to ca. 6 mm long, glabrate (especially above); **petioles** 0-3 mm long; **stems** erect, 3-20 (-40) dm tall, usually branched from the base, the branches erect to spreading, very leafy, glabrous, short-villous or short-pilose, with silvery or rust-colored hairs, stems and branches yellowish-green, green or streaked with red, often turning red or reddish purple in fall; **root system** annual with a taproot (2n = 18).

Infraspecific Variation: Several forms and varieties have been described; those with very narrow, thread-like leaves have been called "*Kochia scoparia* var. *culta* Farw."; those with broader leaves and downy stems have been called "*K. scoparia* var. *pubescens* Fenzl.", while the typical plants have broader leaves and sparsely hairy to glabrous stems.

Importance: Often cultivated in the past and still, occasionally, cultivated as an annual hedge along walkways and driveways and for the red color in fall. In Russia they are cultivated for broom making. This species has one of the most highly allergenic pollen produced in the family.





2. *Bassia hirsuta* (L.) Aschers. ex Schwein.

Common Name: Bassia

Type Description: Linnaeus, Species Pl. I, p. 221, 1753

Origin: A native of Coastal Europe

Habitats: Coastal saline or brackish soils

Habit: Erect, annual herb

Flowering: August

Fruiting: September

General Distribution: Coastal Europe, introduced into the United States along the coast from New England to Maryland

Description: Plants with **bisexual** flowers; **stigmas** 2, erect or spreading, ca. 0.6 mm long; **style** ca. 0.2 mm long; **ovary** depressed-globose; **fruit** depressed-oblong, pericarp free; **seed** horizontal, lenticular, dark brown to black, oblong, 1.2-1.8 mm long, 0.8-1.2 mm broad, 0.4-0.6 mm thick, testa glabrous; **stamens** 5; **filaments** membranaceous, 0.8-1.0 mm long; **anthers** ellipsoid, light yellow, 0.4-0.5 mm long; **perianth** 1.2-2.0 mm wide; **lobes** deltate, 0.9-2.0 mm long, 0.4-0.7 mm wide, pubescent, incurved in flower, persistent and incurved over the seed in fruit, developing short, stout dorsal tubercles on 3 of the lobes, the tubercles 0.5-1.0 mm long; **bracts** absent; **inflorescences** of solitary flowers or in short spikes from the upper leaf axils, 3.5-5.0 cm long; **leaves** fleshy, linear-oblong to linear, semi-terete, 0.5-1.0 cm long, 0.8-1.4 mm broad, apex rounded, pubescent; **petioles** absent; **stems** 1.5-4.0 dm tall, branching from the base, the branches erect, turning pink in autumn; **root system** annual with a taproot (2n = 18).

Importance: This plant has been used on the island of Cyprus for soda extraction.

Waifs: *Bassia hyssopifolia* (Pall.) Kuntze, which differs from *B. hirsuta* in having flat leaves and curved spines up to 1.5 mm long on the fruiting perianths, was found by Joseph Monachino in three locations in Queens Co. in the 1940s, but it has not been reported since.

8. CORISPERMUM

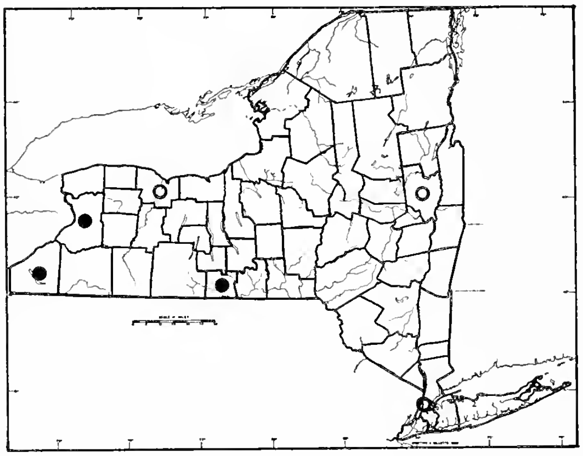
Common Name: Bugseed

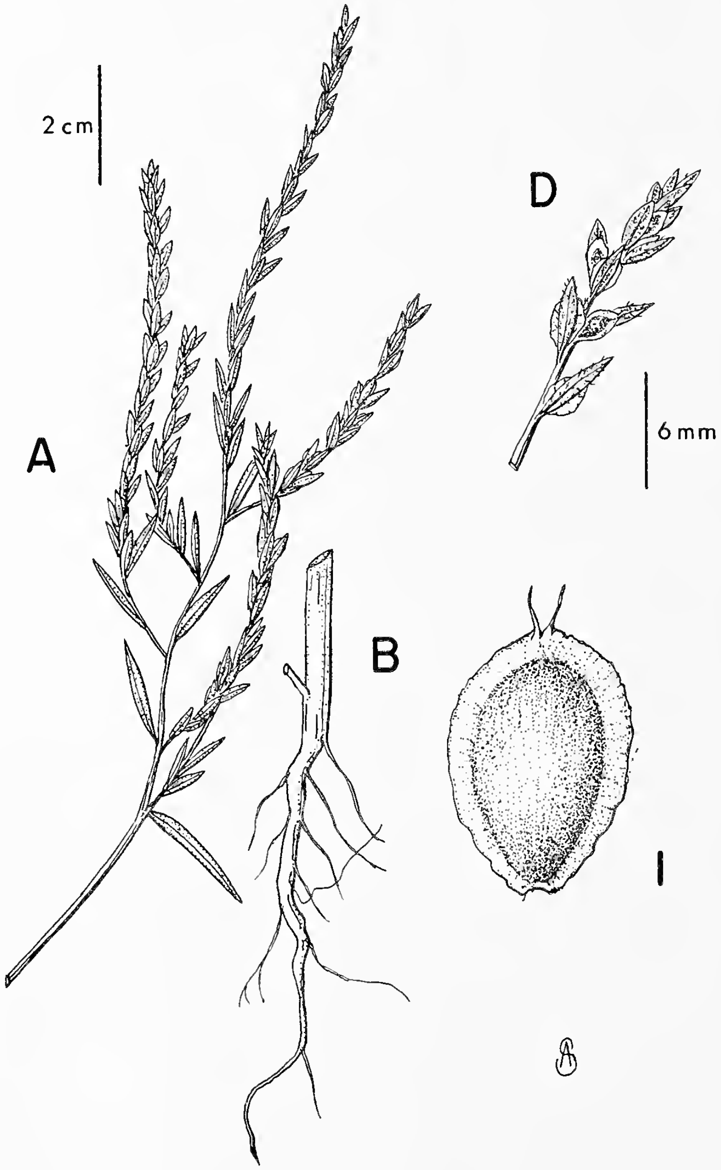
Authority: Linnaeus Species Pl. I, p. 4, 1753

A genus of 60 species in the north temperate parts of the world. The genus is diverse, and distinctions between species are often difficult to make. For instance, one important character is the presence of winged fruit; however, Brooks (1986) stated that some plants have both winged and wingless fruits. The North American plants needs to be studied in connection with Eurasian materials.

KEY TO SPECIES

1. Fruit lacking conspicuous wing-margins .... [*C. orientale*, a waif]
1. Fruit conspicuously wing-margined .... (2)
   2. Spikes dense; bracts closely overlapping and all at least as broad as the fruit .... 1. *C. hyssopifolium*
   2. Spikes loose; bracts not distinctly overlapping, especially along lower-most portion of spike, and at least the lower bracts much narrower than the fruit .... [*C. nitidum*, a waif]





1. *Corispermum hyssopifolium* L.

Common Name: Bugseed

Type Description: Linnaeus, Species Pl. I, p. 4, 1753

Synonyms: *Cycloloma hyssopifolium* var. *americanum* Nutt., *C. americanum* Nutt., *C. marginale* Rydb., *C. imbricatum* A. Nels., *C. simplicissinum* Lunell

Origin: A native of Eurasia

Habitats: Sandy fields or beaches

Habit: An erect, annual herb

Flowering: August-September

Fruiting: September-October

General Distribution: Illinois to North Dakota and Idaho south to Texas and Arizona

Description: Plants with **bisexual** flowers; **stigmas** 2, subfiliform, recurved, ca. 0.4 mm long; **style** 1, ca. 0.6

mm long; **ovary** 1, ovoid, unilocular, with a single, basal **ovule**; **fruit** an oval to rounded, flattened or concave, indehiscent utricle, 3.3-4.2 mm long, 2.0-2.8 mm broad, exserted from the perianth, but usually hidden by the bract, the margin with a pale wing, 0.2-0.5 mm wide, pericarp somewhat hardened and loosely surrounding the seed, non-adherent; **seed** 1, vertical, homomorphic, stramineous, oval, 3.5-4.0 (-5) mm long, 1-2 (-4) mm broad, testa glabrous; **embryo** annular; **perisperm** abundant, farinose; **radicle** basal; **stamens** 1-3 (-5), hypogynous; **filaments** linear, membranaceous, 0.5-1.0 mm long, distinct; **anthers** tetrasporangiate, ellipsoid, yellow, 0.3-0.5 mm long; **perianth** 1 sepal, scarious, oblong, 0.6-1.0 mm long, 0.4-0.9 mm broad, apex rounded; **bract** often imbricate, linear to oval, usually erect, 4-10 mm long, 2.0-2.6 mm broad, acute or acuminate, stellate pubescent or glabrate, the lowest longer and narrower, all except the lowest as broad as or broader than the fruit, these rarely narrower; **bracteoles** absent; **inflorescences** terminal and axillary spikes 4-9 cm long, 4-8 mm broad, the flowers at each node solitary or in glomerules; **leaves** simple, alternate, herbaceous, broadly linear, 0.5-4.0 (-9) mm long, 0.1-0.3 (-0.5) mm broad, entire, cuspidate, glabrous or stellate-pubescent; **petioles** absent; **stems** herbaceous, slender, much-branched, 1.5-6.0 dm tall, the branches spreading, striate, glabrous or stellate-villous, often tinged with red, sparsely leafy; **root system** annual with a taproot.

Waifs: *Corispermum nitidum* Kitaibel ex Schultes has been collected in Buffalo (Erie Co.), Rochester (Monroe Co.), and Mechanicsville (Saratoga Co.); *C. orientale* Lamarck was collected in Buffalo (Erie Co.) and New York City (New York Co.) in the nineteenth century but not since.

9. POLYCNEMUM

Common Name: Polycnemum

Authority: Linnaeus, Species Pl. I, p. 35, 1753

A genus of 6-7 species, native to Europe and central Asia.

Waif: *Polycnemum majus* A. Br., was collected at Moquette Mill, Yonkers (Westchester Co.) in 1890.

10. AXYRIS

Common Name: Russian Pigweed

Authority: Linnaeus, Species Pl. II, p. 979, 1753

A genus of seven species native to northern Asia and Europe; *A. amaranthoides* is often a contaminant of grain in Europe, and it has now become naturalized in the Great Plains.

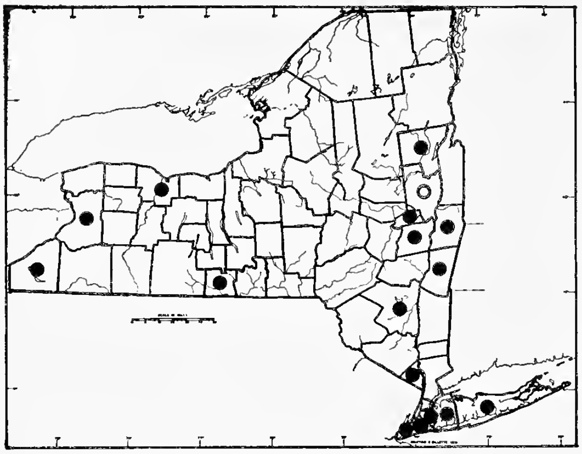
Waif: *Axyris amaranthoides* L. appeared at the Port of Albany (Albany Co.) and was collected in 1950.

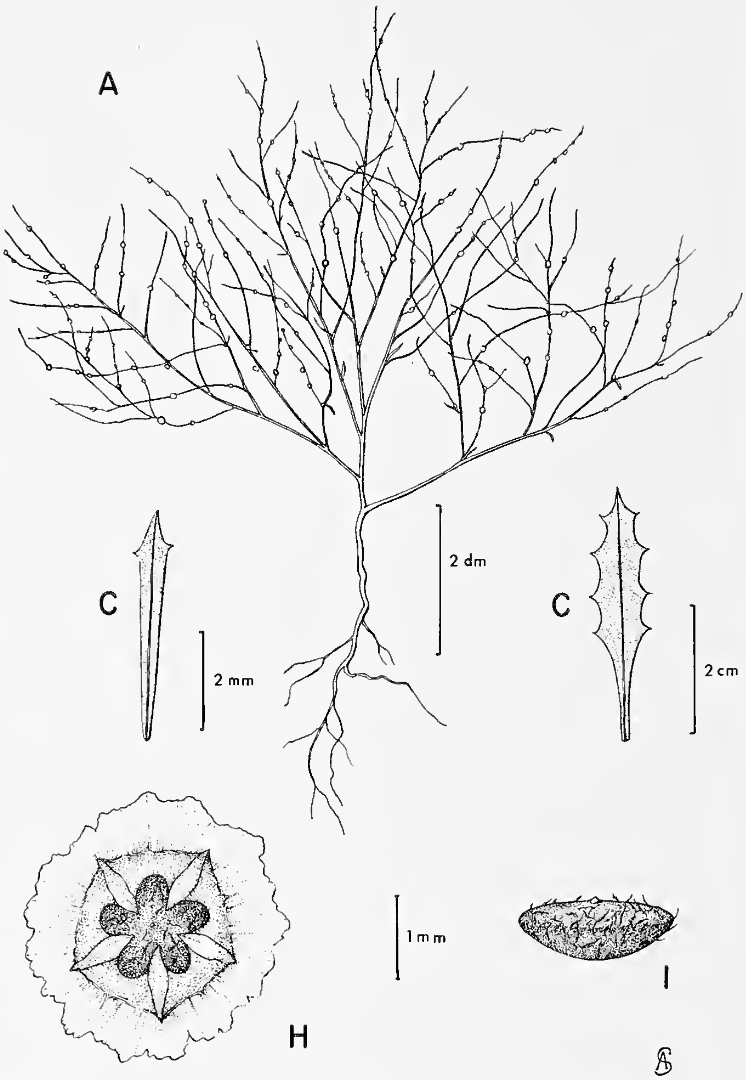
11. CYCLOLOMA

Common Name: Winged Pigweed

Authority: Moquin-Tandon, Chenop. Monogr. Enum. p. 17, 1840

A monotypic genus native to North America.





1. ***Cycloloma atriplicifolium*** **(Spreng.) Coult.**

Common Name: Winged Pigweed

Type Description: Sprengel, Bot. Gart. Hal. Nachr. 1:35, 1801

Synonym: *Salsola atriplicifolia* Spreng.

Origin: A native of central North America

Habitats: Sandy fields, beaches, blowouts, roadsides and waste places

Habit: A densely-branched, erect to spreading annual herb

Flowering: July-September

Fruiting: August-November

General Distribution: Native from Indiana to Saskatchewan south to Mexico and Texas, now introduced eastward to Quebec, New York and New Jersey

Description: Plants **polygamodioecious**; **stigmas** 3, subfiliform, erect or spreading, 0.5-1.0 mm long; **style** 1, ca. 0.1 mm long, or absent; **ovary** 1, superior, depressed-ovoid, densely tomentose, unilocular with a single basal **ovule**; **fruit** a depressed-globose, indehiscent utricle, pericarp membranaceous, pubescent, non-adherent, closely investing the seed and nearly the same size; **seed** 1, horizontal, lenticular, black, 1.4-1.5 mm in diameter, 0.8-1.0 mm thick, testa glabrous; **embryo** annular; **perisperm** farinose, abundant; **radical** centrifugal; **stamens** 5, hypogynous; **filaments** subulate, membranaceous, 1.0-1.2 mm long; **anthers** tetrasporangiate, oblong, yellow, 0.2-0.3 mm long; **perianth** 5-lobed, hemispheric, developing a broad, dentate, membranaceous wing, 2.5-4.0 mm diameter, more or less villous, becoming red or purple in fruit; **lobes** triangular-ovate, 0.4-0.6 mm long, 0.4-0.8 mm broad, inflexed, apex obtuse, carinate; **bract** narrowly oblong to narrowly elliptic, 0.3-1.0 cm long, 0.3-0.9 mm broad, entire or toothed; **bracteoles** absent; **inflorescence** a broad panicle, 9-19 cm long, 5-15 cm broad, the flowers solitary at each node, sessile; **leaves** simple, alternate, herbaceous, oblong or narrowly oblong, 2-8 cm long, 0.6-1.5 cm broad, apex acute, base usually tapering to a petiole, margins coarsely and irregularly sinuate-dentate, teeth acute, mucronate, young leaves white-tomentose, becoming glabrate, then usually falling from fruiting plant; **petioles** 0-8 mm long; **stems** herbaceous, erect or spreading, densely branched, 1.5-8.0 dm tall, as broad as tall, the branches slender, obtusely angled, striate, white villous-tomentose when young, becoming glabrate; **root system** annual with a taproot.

12. MONOLEPIS

Common Names: Poverty Weed, Spear-leafed Goosefoot, Monolepis

Authority: Schrader, Index Semin. Horti Acad. Goeth. p. 4, 1830

A genus of 3-6 species native to northern Asia, North America and Patagonia.

Waif: *Monolepis nuttalliana* (Schultes) Greene, was collected once at Cornell University (Tompkins Co.) in 1932 and has been reported from Monroe County.

13. CHENOPODIUM

Common Names: Pigweed, Goosefoot

Authority: Linnaeus, Species Pl. I, p. 218, 1753

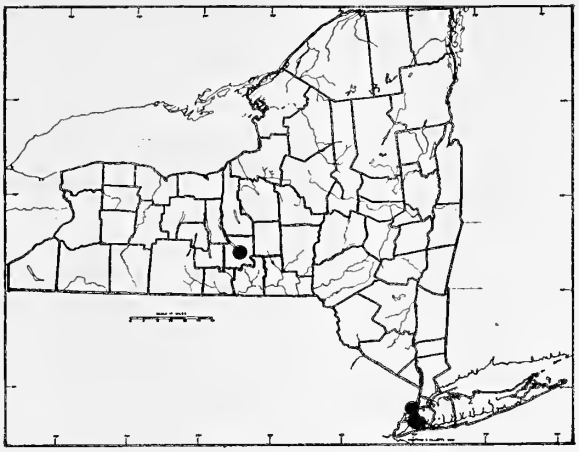
A genus of 70-150 species worldwide. The plants are often associated with xeric environments and most species are weedy within and outside their ranges. *Chenopodium* is notorious for its taxonomic difficulty, largely attributable to phenotypic plasticity, but with some of the variability resulting from hybridizations. Compounding this situation is the large number of species named within the past 75 years, particularly within the *Chenopodium album* complex, leading to many conflicting taxonomic treatments. Many of these recently-described taxa are probably best considered varieties of earlier-named species. Some pigweeds are well-known as tumbleweeds and noxious garden pests. Other species are grown as pot-herbs, and *C. ambrosioides* L., Mexican tea, is extracted for "oil of chenopodium," which has medicinal properties. Quinoa (*C. quinoa* Willd.) is a South American grain staple in the highlands of the Andes. Scott (1978b) reviewed the classification of the subtribe Chenopodiinae (including *Blitum*, *Chenopodium*, *Dysphania*, and *Monolepis*). In his review he placed *Chenopodium capitatum* and related species in the genus *Blitum*, based upon the fleshy perianth, vertical seed with a superior radicle, and the hippocrepiform embryo. I have followed the more traditional concept of *Chenopodium* by continuing to include these species within the genus. I feel that further comparative studies with other genera of the family are needed to clarify the morphological lines along which *Chenopodium* might best be split.

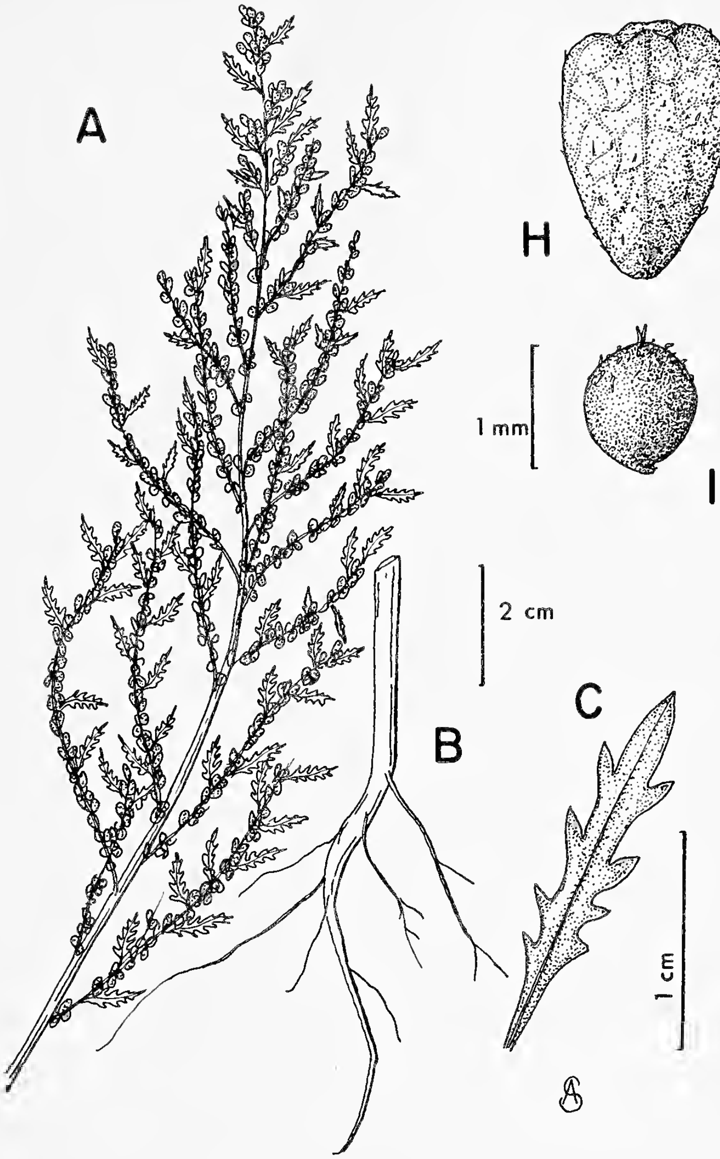
Description: Plants with **bisexual** or rarely **unisexual** flowers, then the terminal flower of glomerules often male or bisexual and the lateral female; **stigmas** 2-5, filiform; **style** 1, or usually absent; **ovary** 1, superior, unilocular with a single basal **ovule**; **fruit** an indehiscent utricle, often enclosed in the infolded perianth, the pericarp membranaceous or fleshy, adherent or not; **seed** 1, horizontal or vertical, usually lenticular; **embryo** annular or incompletely annular, surrounding the copious farinaceous **perisperm**, the **radicle** inferior or centrifugal; **stamens** 5 or fewer, hypogynous or subperigynous; **filaments** linear, distinct or sometimes connate at the base; **anthers** tetrasporangiate; **perianth** a single series, usually 5 lobes, rarely 3-4, commonly united at least at their bases; **bract** present or absent, usually subtending glomerules, blade-like or needle-like; **bracteoles** absent; **inflorescences** terminal or axillary spikes, or the flowers often clustered into axillary glomerules; **leaves** simple, alternate, herbaceous, pinnatifid, usually unlobed, margin entire, dentate or serrate; **petioles** present or absent; **stems** herbaceous, rarely suffrutescent, usually either glandular or farinaceous, covered with small, white, inflated hairs; **annual** or **perennial** from shallow **root systems**, or, more often from a taproot.

KEY TO SPECIES

1. Calyx not obviously veined, sepals usually fused only near the base; leaves entire, toothed or lobed (rarely pinnatifid) ......(2)
1. Calyx veined, connate nearly to the sepal tips; leaves deeply pinnatifid ....1. *C. multifidum*
    2. Plants variously pubescent or glandular pubescent but not completely glabrous or farinose (mealy) ....(3)
    2. Plants glabrous or farinose ....(6)
3. Seeds chiefly horizontal, 0.7-1.0 mm broad ....(4)
3. Seeds vertical, 0.5-0.7 mm broad (flowers in small glomerules in the axils of the lobed leaves) ....2. *C. pumilio*
    4. Leaves linear, entire or nearly so; plants not aromatic . ...[*C. aristatum*, a waif]
    4. Leaves lanceolate, serrate, dentate or lobed; plants aromatic ....(5)
5. Flowers in glomerules and short spikes, the upper bracteate; lower leaves serrate, the upper leaves entire; pericarp smooth ....3. *C. ambrosioides*
5. Flowers solitary or in small cymes, ebracteate; leaves all pinnatifid; pericarp reticulate, having black and white stripes circling 2/3 of the seed ....4. *C. botrys*

6. Seeds vertical, occasionally with a few horizontal seeds in the same inflorescences .... (7)
6. Seeds horizontal, rarely with vertical seeds in the same inflorescences .... (11)
7. Plants perennial; stigmas more than 0.8 mm long; seeds more than 1.5 mm diameter .... 5. *C. bonus-henricus*
7. Plants annual; stigmas less than 0.8 mm long; seeds less than 1.5 mm diameter .... (8)
8. Leaves glabrous, the undersurfaces not white or sparsely whitened; flowers in globose heads .... (9)
8. Leaves farinose, the undersurfaces white; flowers not in heads or glomerules .... 6. *C. glaucum*
9. Terminal flower vertical like the others; flowers borne in capitate glomerules; fruits fleshy, bright red .... (10)
9. Terminal flower horizontal, the others vertical; flowers borne in irregular glomerules; fruits usually not fleshy, green .... 7. *C. rubrum*
10. Glomerules subtended by bracts .... [*C. foliosum*, a waif]
10. Glomerules not subtended by bracts .... 8. *C. capitatum*
11. Primary leaves linear, ca. 5 times longer than wide, less than 2 cm in width .... (12)
11. Primary leaves deltoid, rhombic, oblong, or ovate, ca. 3 times longer than wide, usually more than 2 cm in width .... (13)
12. Flowers in small cymes; plants glabrous or pubescent .... [*C. aristatum*, a waif]
12. Flowers in glomerules, farinose (mealy) .... 9. *C. pratericola*
13. Fruits maturing unevenly, such that mature fruit and young perfect flowers may be present in a glomerule at the same time; leaves thin; sepals weekly or not at all keeled .... (14)
13. Fruits maturing synchronously within the glomerules, most of them appearing to be at the same stage of development; leaves thin, membranaceous or coriaceous .... (15)
14. Leaf margins with short, ascending teeth; leaves rounded or tapered at the base, gradually reduced upward on the stem, intergrading with entire inflorescence bracts; seeds 1.1-1.5 mm in diameter .... 10. *C. standleyanum*
14. Leaf margins coarsely dentate; leaves subtruncate to cordate at the base; inflorescence ebracteate or the main branches subtended by rather well-developed leaves; seeds 1.5-2.5 mm in diameter .... 11. *C. simplex*
15. Inflorescence-axes and abaxial sepal surfaces glabrous .... (16)
15. Inflorescence-axes and abaxial sepal surfaces copiously farinose (mealy), at least when young .... (17)
16. Leaves ovate to oblong, entire, or rarely with a single, inconspicuous tooth on each margin; stems 4-angled .... [*C. polyspermum*, a waif]
16. Leaves deltate, the margins dentate; stems not 4-angled .... 12. *C. urbicum*
17. Leaves entire, rhombic to ovate, ill scented .... [*C. vulvaria* L., a waif]
17. Leaves dentate, serrate, or sinuously-dentate, rarely entire .... (18)
18. Seeds with acute margins; testa minutely and closely pitted .... 13. *C. murale*
18. Seeds with obtuse margins; testa smooth or alveolate- reticulate .... (19)
19. Perianth lobes united to above the widest portion of the seed; leaves with 3 basal lobes .... [*C. opulifolium*, a waif]
19. Perianth lobes not united or united only at the base; leaves dentate serrate .... (20)
20. Sepals spreading, not closed over the seed; leaves serrate; seeds oval in outline .... 14. *C. strictum*
20. Sepals closed over the seed; leaves dentate and lobed; seeds round in outline .... (21)
21. Pericarp alveolate-reticulate or reticulate .... 15. *C. berlandieri*
21. Pericarp smooth or mottled .... 16. *C. album*





1. ***Chenopodium multifidum*** **L.**

Common Name: Cut-leaf Goosefoot

Type Description: Linnaeus, Species Pl. I, p. 220, 1753

Synonym: *Roubieva multifida* (L.) Moq.

Origin: A native of South America

Habitats: Waste ground and ballast dumps

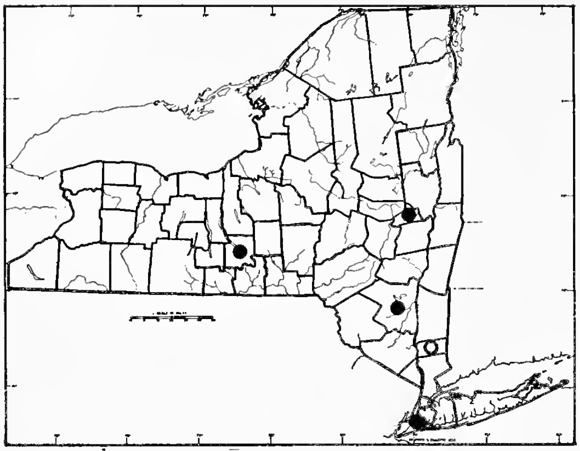
Habit: Prostrate to ascending perennial herbs

Flowering: July-October

Fruiting: July-October

General Distribution: Brazil to Argentina and Chile; adventive in North America, near the coast, from New York to Florida and from Oregon to California

Description: Plants with **bisexual** flowers; **stigmas** 2 (-5), erect or spreading, 0.3-0.4 mm long; **style** 0.1-0.2 mm long; **ovary** ovoid to oblong; **fruit** obovoid, the pericarp membranaceous with many yellow, glandular hairs near the apex, smooth, loosely adherent; **seed** vertical, dark reddish-brown, suborbicular to ovoid, 0.8-1.1 mm long, 0.8-0.9 mm broad, testa smooth; **stamens** 5; **filaments** membranaceous, 0.7-0.9 mm long; **anthers** ellipsoid, yellow, 0.4-0.5 mm long; **perianth** urceolate, shallowly 5-lobed, 1.5-2.0 mm long, 1.1-1.3 mm broad in fruit, obovoid, reticulate-nerved, puberulent; **lobes** 0.1-0.5 mm long, 0.6-0.8 mm broad, rounded, accrescent and coriaceous with age; **bracts** and **bracteoles** absent; **inflorescence** of glomerules in the axils of leaves; **glomerules** subglobose, 1.8-2.5 mm in diameter; **leaves** oblong, deeply pinnatifid, 1.0-4.5 cm long, 0.2-2.0 cm wide, or the upper smaller segments oblong, apex acute to obtuse, entire or dentate; **petioles** absent; **stems** much-branched, the branches prostrate or ascending, 1.5-7.0 dm long, striate, white villous when young, sometimes glabrate with age; **root system** annual with a taproot.



2. *Chenopodium pumilio* R.Br.

Common Name: Goosefoot

Type Description: R. Brown, Prodr. 1: 407, 1810

Synonym: *C. carinatum*, *sensu* American authors, not R. Br.

Origin: Native to Australia

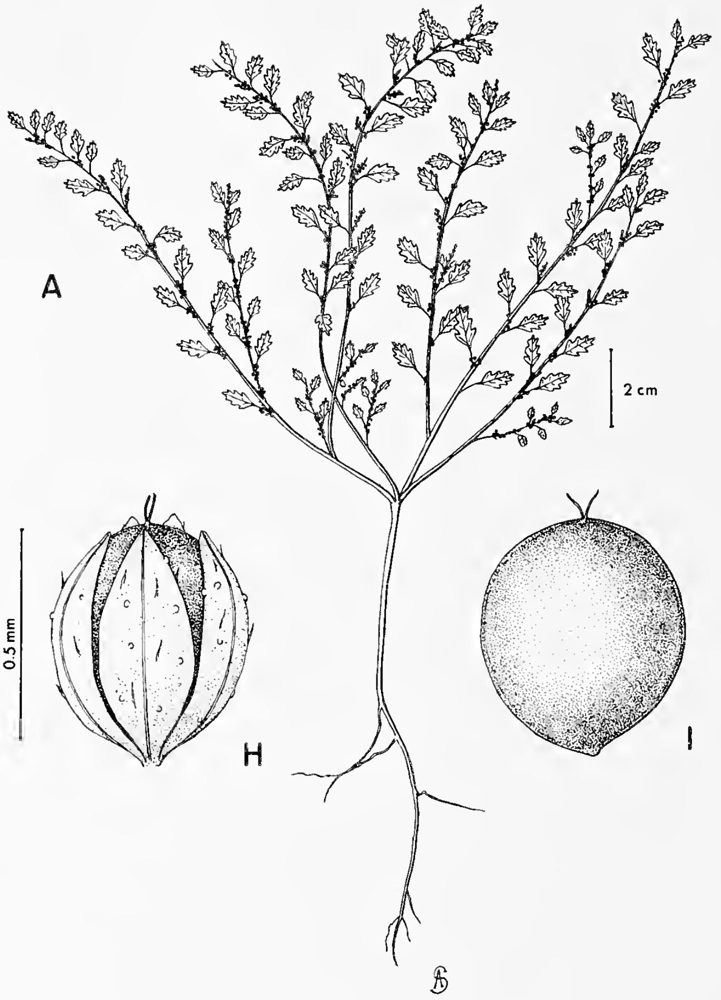
Habitats: Waste areas on rocky, sandy, or gravelly ground and sidewalk crevices

Habit: Erect, annual herbs

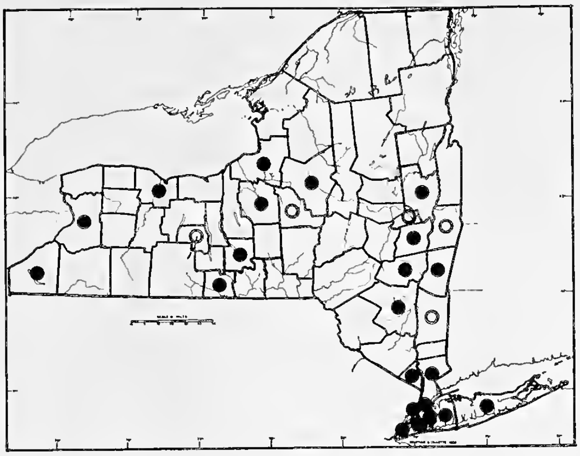
Flowering: June-September

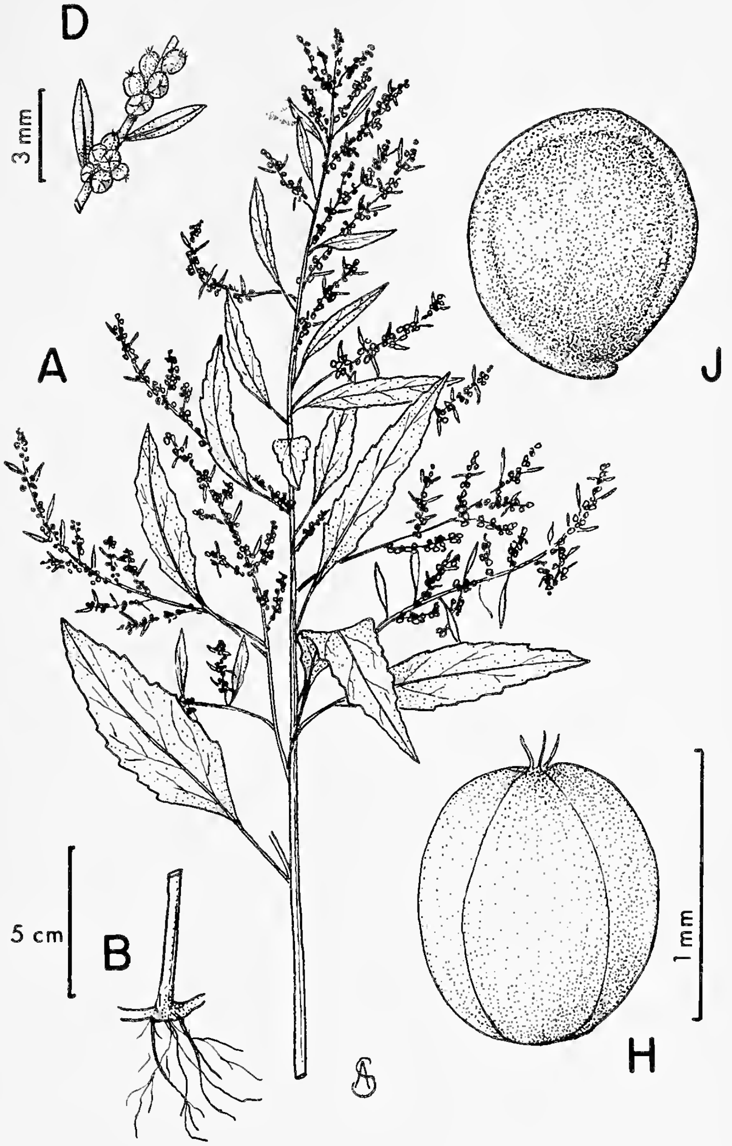
Fruiting: August-October

General Distribution: Australia: introduced in North America from Massachusetts south to Washington D.C., and from Missouri to Texas and California



Description: Plants with **bisexual** flowers; **stigmas** 3, erect or spreading, 0.1-0.3 mm long; **style** absent; **ovary** ovoid; **fruit** ovoid, the pericarp membranaceous, slightly rugose, adherent; **seed** vertical, reddish brown, ovoid, 0.6-0.7 mm long, 0.5-0.6 mm broad, testa smooth; **stamens** 0 or 1; **filaments** membranaceous, 0.3-0.4 mm long; **anthers** globose, yellow, 0.2-0.3 mm long; **perianth** 5-lobed; **lobes** elliptic to oblong, 0.6-0.7 mm long, 0.2-0.3 mm broad, usually cucullate or carinate, apex acute, usually covered with glands, partially enclosing the seed, united only at the base; **bract** 3-16 mm long, 0.4-6.0 mm broad, elliptic, apex obtuse, margin crenate dentate, petiolate; **bracteoles** absent; **inflorescences** of axillary glomerules or axillary cymes; **glomerules** subglobose, 1.5-2.5 mm in diameter; **leaves** oblong to ovate-oblong, 1.4-2.7 cm long, 0.6-1.5 cm broad, reduced somewhat in the inflorescence, yellow-green with yellow glands, the apex obtuse, base cuneate, margins coarsely sinuate-dentate with obtuse lobes; **petioles** 0.3-1.5 cm long; **stems** much-branched from the base, the branches stout, prostrate or 2-4 dm tall, whitish, glandular villous throughout; **root system** annual with a taproot.





3. *Chenopodium ambrosioides* L.

Common Names: Mexican Tea, Spanish Tea, Wormseed

Type Description: Linnaeus, Species Pl. I, p. 219, 1753

Synonyms: *Chenopodium ambrosioides* var. *anthelminicum* (L.) A. Gray, *C. ambrosioides* var. *chilense* of New York authors not (Schrad.) Speg., *C. anthelminicum* L.

Origin: A native of tropical America

Habitats: Disturbed areas as a weed

Habit: Erect or ascending, annual or short-lived, perennial herbs

Flowering: August-October

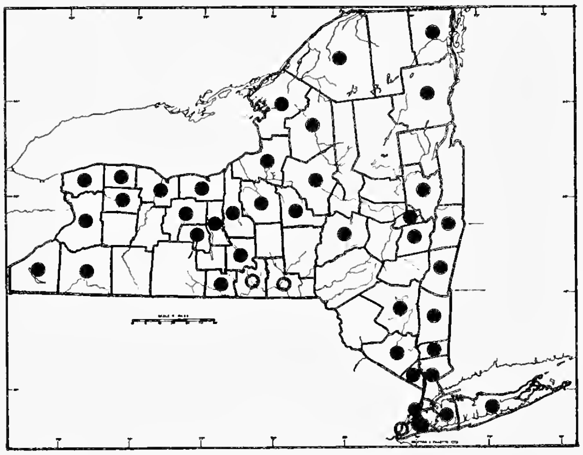
Fruiting: August-November

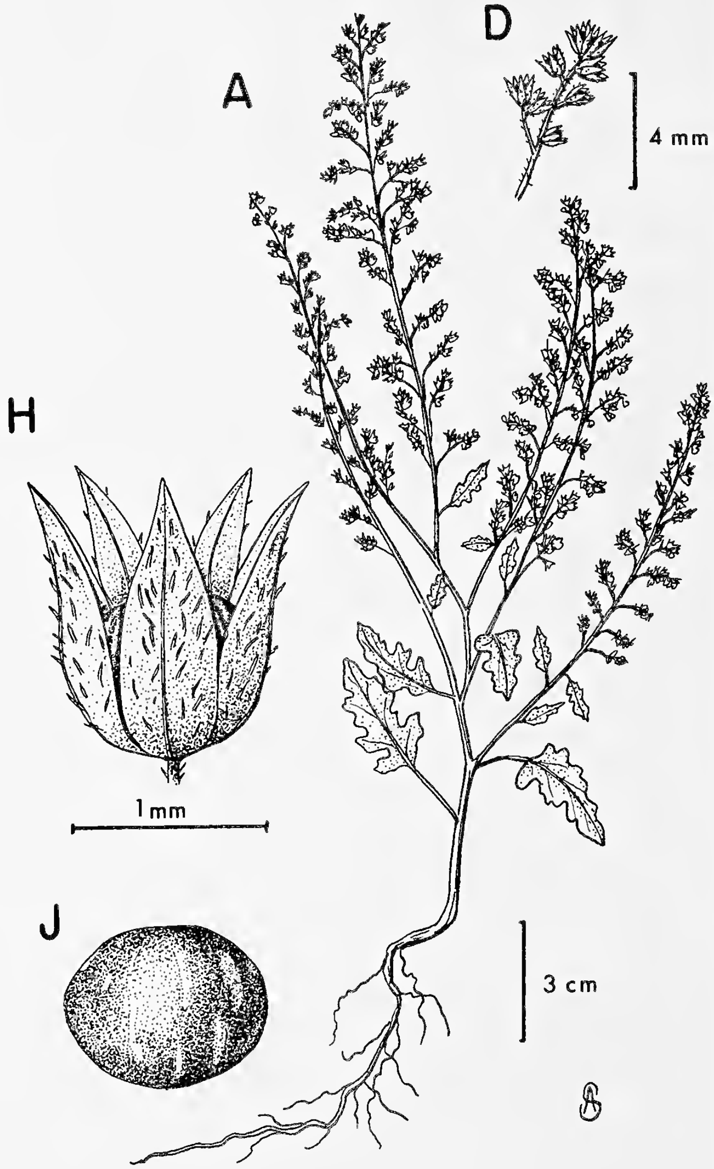
General Distribution: Maine to southern Ontario, south to Central America; also introduced in Europe, Asia and Africa

Description: Plants with **bisexual** flowers; **stigmas** 3, erect or spreading, 0.2-0.4 mm long; **style** absent; **ovary** ovoid; **fruit** ovoid, the pericarp rugose to smooth, non-adherent; **seed** horizontal or vertical, reddish-brown, ovoid, 0.6-1.0 mm in diameter, 0.4-0.5 mm thick, testa rugose to smooth; **stamens** 4-5; **filaments** membranaceous, 0.5-0.7 mm long; **anthers** globose, yellow, 0.3-0.4 mm long; **perianth** 4-5 lobed; **lobes** ovate, 0.7-1.0 mm long, 0.4-0.5 mm broad, obtuse on back, apex obtuse, upper half free, covering the seed at maturity; **bract** lanceolate, oblanceolate, spatulate or linear, the apex obtuse, acute or attenuate, 0.3-2.5 cm long, 0.5-7.0 mm broad; **bracteoles** absent; **inflorescences** lateral leafy-bracted or naked spikes, 3-7 cm long; **leaves** with the smell of kerosene, ovate to oblong-lanceolate, the lower ones mostly lanceolate, 2-8 (-12) cm long, 0.5-4.0 (-5.5) cm wide, entire, dentate or laciniate, apex obtuse to attenuate, base cuneate, copiously glandular-punctate (glands rarely lacking); **petioles** on lower leaves to ca. 18 mm long, upper leaves sessile; **stems** erect to ascending, much-branched, 3-10 dm tall, more or less glandular-pubescent, strongly aromatic; **root system** annual with a taproot (2n = 16, 32, 36, 48?, 64).

Infraspecific Variation: This is a highly variable species or group of species. In New York State, two morphological variants occur: plants with leafy bracts interrupting the inflorescence (typical *C. ambrosioides*), and plants without bracts, "*C. anthelminicum*." According to Woroschilov (1942) typical *C. ambrosioides* takes 60-75 days to mature, while *C. anthelminicum* takes 145 days. There are, however, many apparent morphological intermediates, and the taxonomy of the group has not been resolved. It is treated here as a single, polymorphic species.

Importance: *Chenopodium ambrosioides* has been used as medicine to treat numerous ailments. Perhaps the most important use has been as a vermifuge (particularly for roundworms). The active ingredient is the volatile oil, Ascaridol, which has proven very effective, but its serious overdose side-effects have sometimes lead to death. Loss of human life from ingesting leaves or seeds, however, has not been reported. *Chenopodium* extract has also been used as a fever-reducing stomatic, an expectorant, treatment to soothe menstrual cramps, and it has been administered in larger doses to induce fetal abortion. The leaves have been used to make a weak tea, and the extract serves as a food flavoring in Mexico. The essential oil is allelopathic to many other plants, including vegetables, so, in Mexico, it is often grown in a secluded corner of the garden.





4. *Chenopodium botrys* L.

Common Names: Jerusalem-oak, Feather-geranium

Type Description: Linnaeus, Species Pl. I, p. 219, 1753

Origin: A native of Europe

Habitats: Waste places and sandy shores, occasionally a weed along roads and in waste areas

Habit: An erect, annual, herb

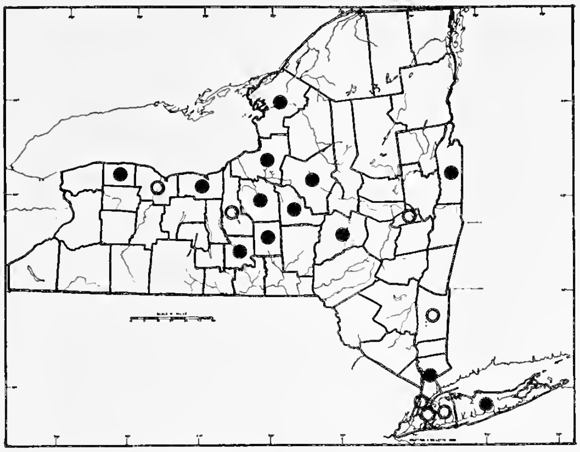
Flowering: July-September

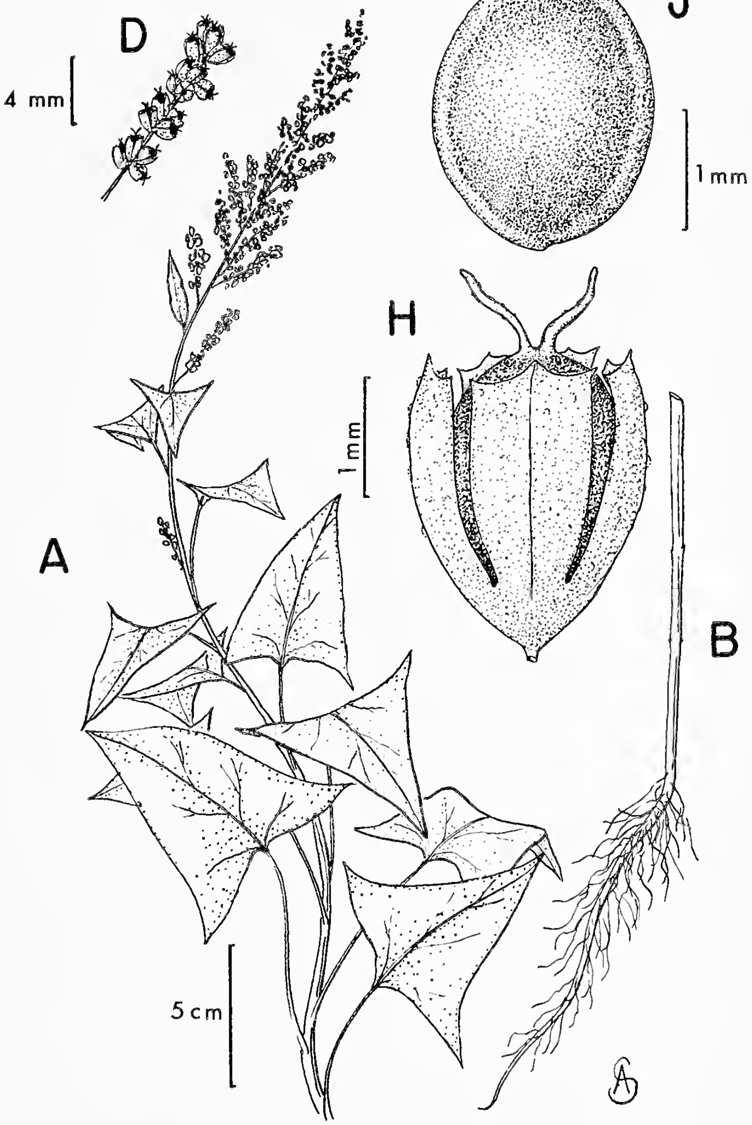
Fruiting: August-October

General Distribution: Europe and Asia; naturalized in North America from Quebec to the Northwest Territories and south to California, Missouri and Virginia

Description: Plants with **bisexual** flowers; **stigmas** 2, erect, 0.2-0.5 mm long; **style** absent; **ovary** ovoid; **fruit** depressed-ovoid, the pericarp membranaceous, rugose, usually with translucent, whitish stripes, adherent; **seed** usually horizontal, black, ovoid-globose, 0.6-0.8 mm broad, 0.5-0.6 mm thick, testa rugose; **stamens** 5; **filaments** membranaceous, 0.7-0.8 mm long; **anthers** globose, yellow, 0.2-0.3 mm long; **perianth** 5-lobed; **lobes** elliptic, ovate to oblong, 0.7-0.9 mm long, 0.5-0.6 mm broad, obtuse on the abaxial surface, apex acute to obtuse, densely glandular-pubescent abaxially, lobes covering the seed at maturity, united only at the base; **bract** and **bracteoles** absent; **inflorescence** of terminal, compound cymes, (9-) 17-23 cm long; **glomerules** absent; **leaves** lanceolate to narrowly elliptic, ovate, 1.5-4.0 cm long, 0.6-2.7 cm broad, upper leaves much smaller, margins sinuate, pinnatifid, occasionally entire; **petioles** 0-2.5 mm long; **stems** erect, branched, 9-47 (-60) cm tall, covered with short-stalked, glandular hairs, slightly aromatic; **root system** annual with a taproot (2n = 18).

Importance: Pollen of this species has been cited as a cause of hay fever. In France, the extract has been used as an expectorant.





5. *Chenopodium bonus-henricus* L.

Common Name: Good-King-Henry

Type Description: Linnaeus, Species Pl. I, p. 218, 1753

Origin: A native of Europe

Habitats: Waste places and cultivated ground

Habit: An erect, perennial herb

Flowering: June-August

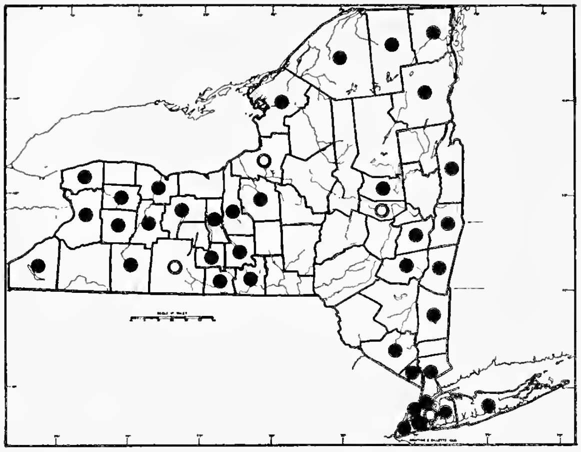
Fruiting: June-October

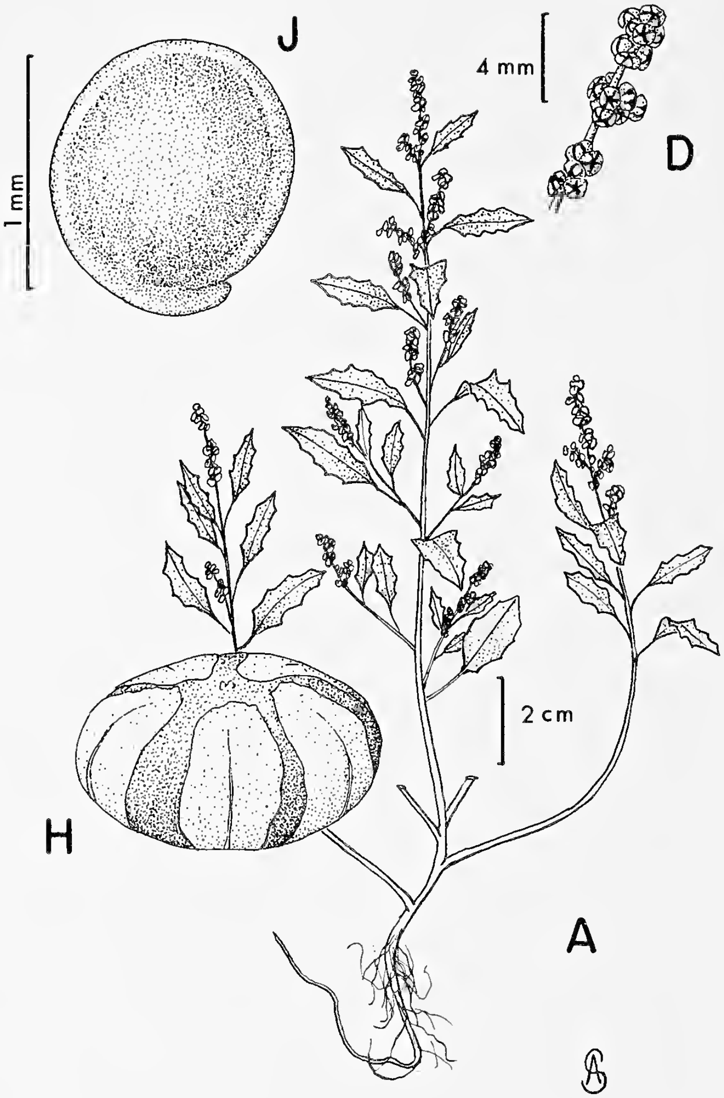
General Distribution: Adventive from Europe; in North America: from Nova Scotia to Alberta south to Illinois and New York

Description: Plants with **bisexual** flowers; **stigmas** 2, spreading, 0.6-1.2 (-1.5) mm long; **style** absent; **ovary** ovoid or obovoid; **fruit** obovoid, pericarp membranaceous, more or less smooth, adherent; **seed** vertical, reddish-brown, obovoid, 1.5-1.7 mm long, 1.4-1.6 mm wide, testa rugose; **stamens** 5; **filaments** 0.5-0.6 mm long, membranaceous; **anthers** ellipsoid, yellow, 0.4-0.6 mm long; **perianth** 4-5 lobed; **lobes** oblong, 1.0-1.5 mm long, ca. 1 mm broad, scarcely abaxially keeled, apex obtuse to rounded, not covering the seed at maturity, glabrous, united into a tube 0.4-0.6 mm long; **bract** ovate to lanceolate, 1-5 cm long, 1.2-4.0 cm broad, apex acuminate, base cuneate; **bracteoles** absent; **inflorescence** mostly terminal, compound spike, 5-13 cm tall, 4-10 cm broad; **leaves** broadly hastate to triangulate, 4.5-10.0 cm long, 3-7 cm broad, apex acute, entire, except for the basal lobes; **petioles** 1-10 cm long; **stems** erect to ascending, branched, 2.5-5.0 (-7) dm tall, somewhat viscid and farinose; **perennial**, with a thick, woody root system (2n = 36).

Importance: This plant has, occasionally, been cultivated for its leaves, which are used like spinach. It is gently laxative and has been used as a remedy for indigestion.

Note: The specific epithet "*bonus-henricus*" was not intended to refer to King Henry but, instead, to distinguish this plant from "*malus Henricus*" or 'bad-Henry' (*Mercurialis annua* L.). The name Henry in this case is said to refer to elves and kobolds ('Heinz' and 'Heinrich').





6. *Chenopodium glaucum* L.

Common Name: Oak-leaf Goosefoot

Type Description: Linnaeus, Species Pl. I, p. 220, 1753

Synonyms: *C. salinum* Standl., *C. glaucum* ssp. *salinum* (Standl.) Aellen

Origin: A native of Europe

Habitats: Waste places, especially soils that are more or less brackish

Habit: Erect, annual, herbs

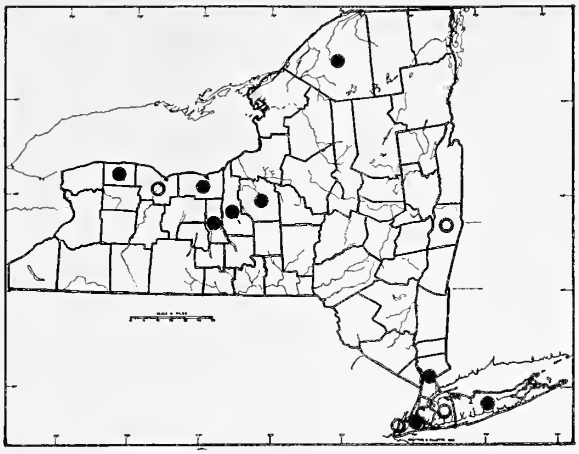
Flowering: July-August

Fruiting: August-September

General Distribution: Nova Scotia west to the Northwest Territories, south to California, Missouri and Virginia

Description: Plants with **bisexual** flowers; **stigmas** 2, spreading, 0.1-0.2 mm long; **style** absent; **ovary** depressed-ovoid; **fruit** ovoid or round in outline, the pericarp membranaceous, smooth, non-adherent; **seed** usually horizontal, but occasionally vertical, reddish brown, vertical seeds ovoid to round in outline, 0.6-0.9 mm in diameter, 0.2-0.3 mm thick, horizontal seeds lenticular, round, 0.7-0.9 mm in diameter, 0.4-0.5 mm thick, testa rugose-punctate; **stamens** 5; **filaments** membranaceous, 0.4-0.5 mm long; **anthers** globose, yellow, 0.2-0.3 mm long; **perianth** 3-5 lobed; **lobes** obovate to oblong, ca. 0.5 mm long, 0.4-0.5 mm broad, obtuse abaxially, apex obtuse, covering the seed at maturity, fused at base; **bract** and **bracteoles** absent; **inflorescence** of axillary or terminal spikes, 5-10 cm tall, the flowers at each node in glomerules; **glomerules** subglobose, 1.8-2.5 mm in diameter; **leaves** lanceolate to oblong or ovate, 0.5-4.0 cm long, 0.3-1.5 cm broad, apex obtuse, base cuneate, margins undulate dentate, teeth obtuse, densely white mealy beneath; **petioles** 0-1 cm long; **stems** erect to prostrate, branched from the base, 0.5-2.5 (-4) dm tall, striate; **annual** with a taproot (2n = 18).

Infraspecific Variation: Material with acute lobed and acute leaf apices and mostly with bracts subtending the flowers have been separated as *C. glaucum* var. *salinum* which is more common in western United States.



7. *Chenopodium rubrum* L.

Common Names: Red pigweed, Red Goosefoot, Coast-blite

Type Description: Linnaeus, Species Pl. I, p. 218, 1753

Synonyms: *Chenopodium chenopodioides* (L.) Aellen, *C. humile* Hook., *C. rubrum* var. *humile* (Hook.) S. Wats.

Origin: Uncertain, possibly native to both North America and Eurasia

Habitats: Salt marshes

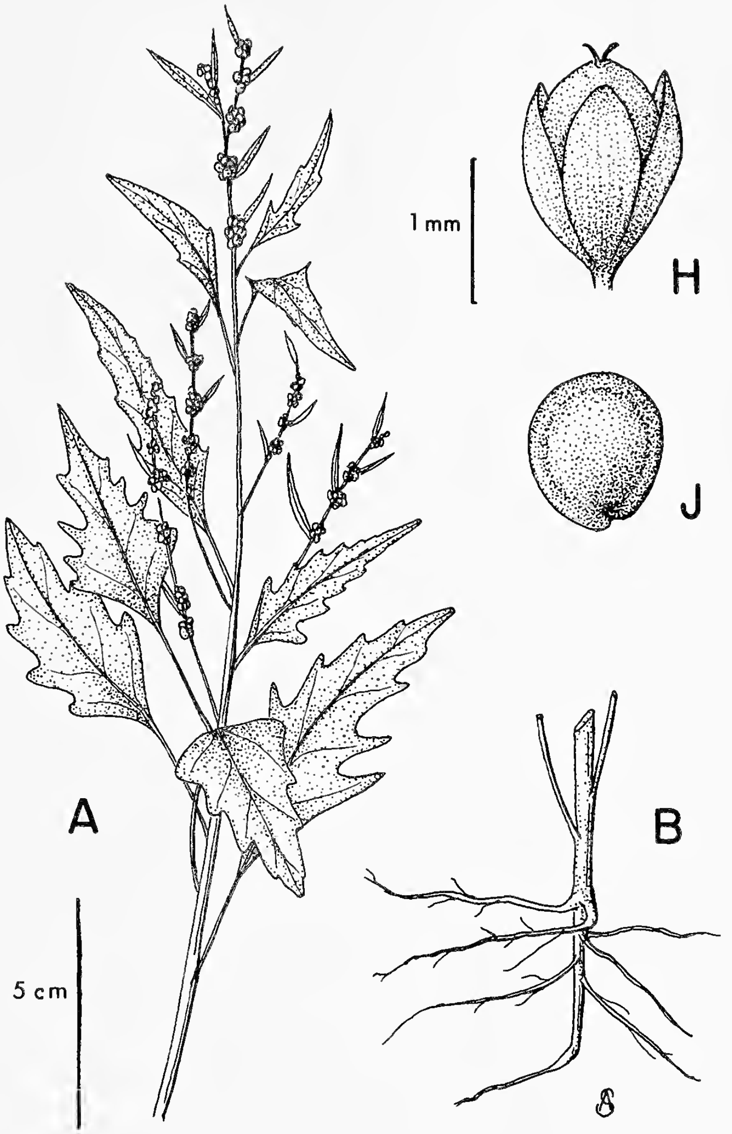
Habit: Erect or spreading, annual herbs

Flowering: August-September

Fruiting: August-October

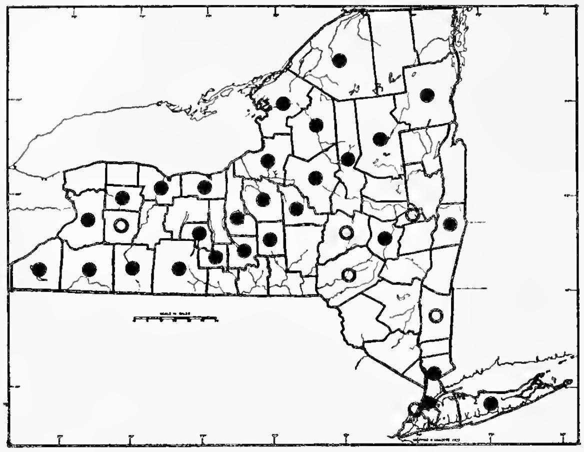
General Distribution: Eurasia; in North America from Nova Scotia to Alaska south to California, Missouri and New Jersey

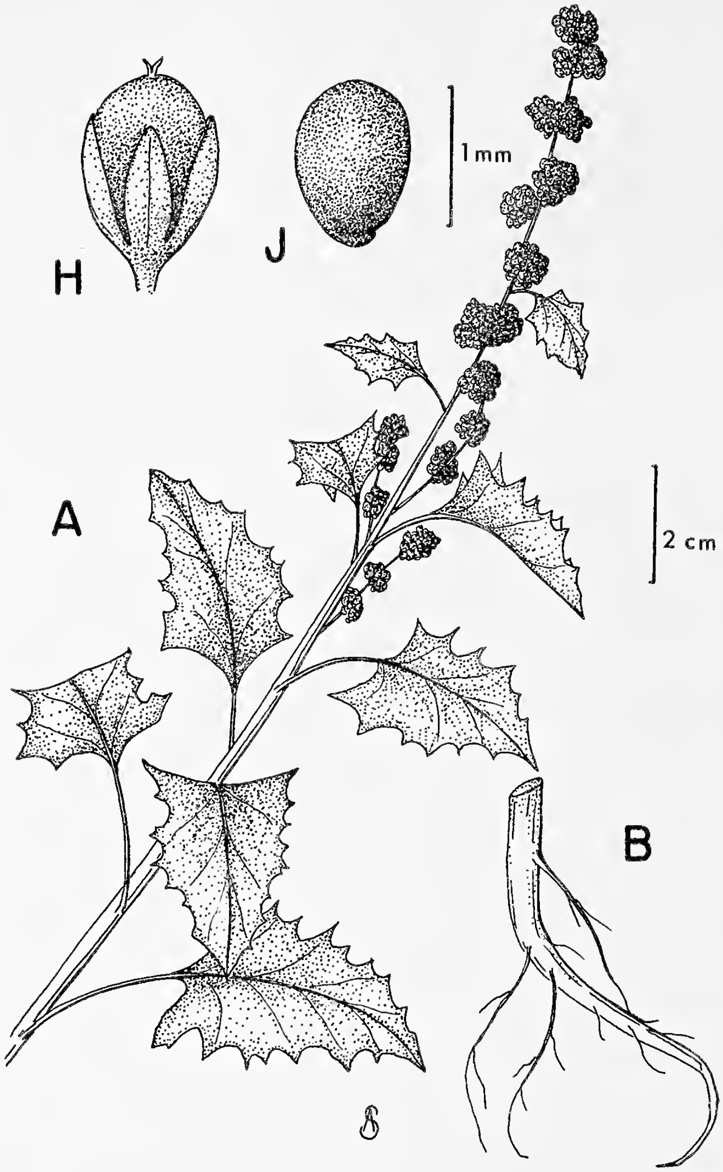
Rarity Status: *Chenopodium rubrum* is ranked G5 S1 by the New York Natural Heritage Program.



Description: Plants with **bisexual** flowers; **stigmas** 2, erect or spreading, 0.1-0.2 mm long; **style** ca. 0.1 mm long or absent; **ovary** ovoid; **fruit** ovoid, pericarp membranaceous, smooth, non-adherent; **seed** vertical or occasionally horizontal, reddish-brown, ovoid, 0.7-1.0 (-1.2) mm high, 0.6-0.8 mm broad, testa reticulate-punctate; **stamens** 5; **filaments** membranaceous, 0.3-0.5 mm long; **anthers** globose, yellow, 0.2-0.4 mm long; **perianth** 5-lobed; **lobes** lanceolate to elliptic, 0.9-1.0 mm long, 1.0-1.2 mm broad, rounded or occasionally keeled on back, apex obtuse to rounded, glabrous, covering the seed at maturity, united only at the base; **bracts** linear, 4-20 mm long, 0.2-1.5 mm broad; **bracteoles** absent; **inflorescence** of axillary glomerules; **glomerules** subglobose, 2-5 mm diameter; **leaves** triangular to rhomboid, 1-9 cm long, 1-6 cm broad, green, tinged with red or purple, especially at bases, fleshy, apex obtuse to acute, base cuneate, margins with a few large, obtuse teeth on each side, rarely entire; **petioles** 0.5-4.5 mm long; **stems** erect to ascending, rarely decumbent, angular, glabrous, much-branched, 3-6 (-8) dm tall; **root system** annual, with a taproot (2n = 18).

Infraspecific Variation: This is a highly variable species worldwide. Smaller, often prostrate plants with nearly entire leaves have been called *C. humile* Hook. *Chenopodium chenopodioides* plants have 3-4 sepals (vs. usually 3 sepals in typical *C. rubrum*) in the flowers with vertical seeds, and sepals united nearly to the tip. Bassett and Crompton (1982) concluded that *C. chenopodioides* and *C. humile* were ecological variants of *C. rubrum*, their treatment is followed here.





8. *Chenopodium capitatum* (L.) Aschers.

Common Names: Strawberry-blight, Indian-paint

Type Description: Linnaeus, Species Pl., I, p. 4, 1753

Synonym: *Blitum capitatum* L.

Origin: Native to Eurasia

Habitats: Dry soil, chiefly in thickets, open woods and in old fields or clearings in forest

Habit: Erect, annual herb

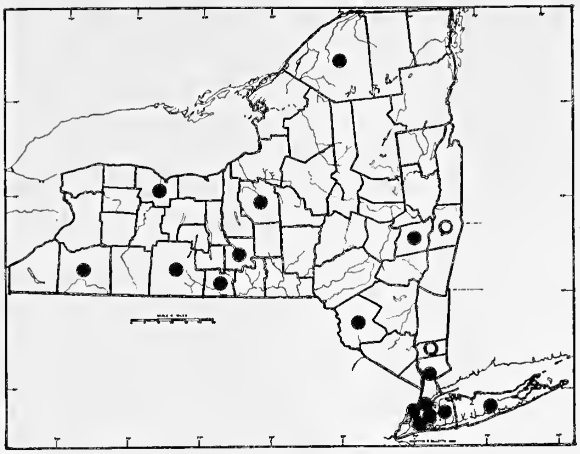
Flowering: June-September

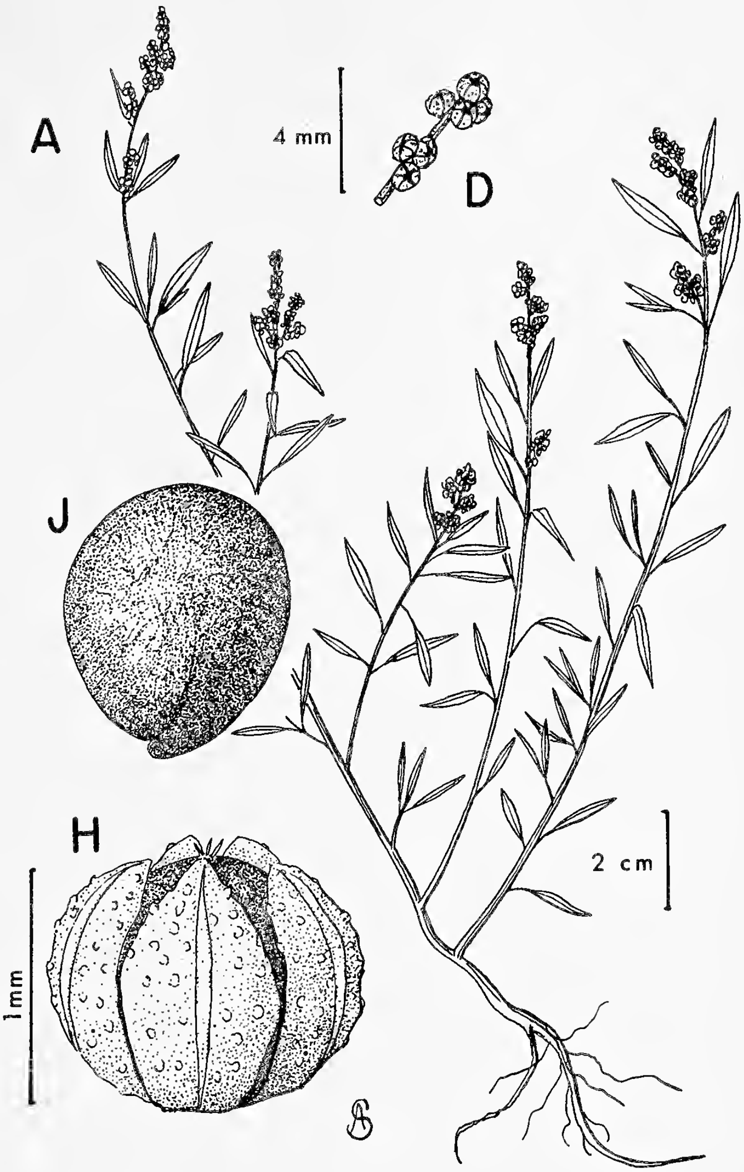
Fruiting: June-September

General Distribution: Eurasia; in North America from Nova Scotia to Alaska south to California, Missouri and New Jersey

Description: Plants with **bisexual** flowers; **stigmas** 2, erect or spreading, 0.2-0.4 mm long; **style** 0.1-0.2 mm long; **ovary** ovoid; **fruit** ovoid, pericarp membranaceous, smooth, adherent; **seed** vertical, black, lenticular, 0.6-0.9 mm broad, 0.7-1.2 mm high, testa reticulate-punctate; **stamens** 3; **filaments** membranaceous, ca. 0.5 mm long; **anthers** globose, light yellow, ca. 0.2 mm long; **perianth** 3-lobed; **lobes** ovate, 0.6-0.7 mm long, 0.4-0.5 mm broad, not keeled, apex acute, becoming deep red and fleshy, covering the seed at maturity, united at the base; **bract** and **bracteoles** absent; **inflorescence** terminal spikes 5-10 cm tall, the flowers in glomerules at the nodes; **glomerules** globose, 5-12 mm in diameter; **leaves** triangular to triangular-hastate, 2.5-10.0 cm long, 1-9 cm broad, apex acute, base truncate, margins sharply dentate or occasionally entire, green on both surfaces, rather fleshy; **petioles** 1.5-10.0 cm long; **stems** erect to ascending, branched from the base, 1.5-7.5 dm tall, glabrous, green, stems angular; **root system** annual with a short taproot (2n = 18).

Importance: The fleshy fruits are sometimes eaten raw or cooked, and the leaves are sometimes cooked as a spinach substitute. The red fruits have been used to color wine and as a rouge.





9. *Chenopodium pratericola* Rydb.

Common Name: Narrowleaf Goosefoot

Type Description: Rydberg, Bull. Torrey Bot. Club, vol. 39, p. 310, 1912

Synonyms: *Chenopodium dessicatum* A. Nels, *C. dessicatum* var. *leptophylloides* (Murr) Wahl., *C. foggii* Wahl, *C. leptophyllum* Nutt. ex Moq. in DC, not S. Wats., *C. pratericola* var. *leptophylloides* (Murr) Aellen & Just

Origin: A native of the western United States

Habitats: Sea beaches, sandy or brackish soils and railroad rights-of-way

Habit: Erect, annual herbs

Flowering: June-August

Fruiting: August-October

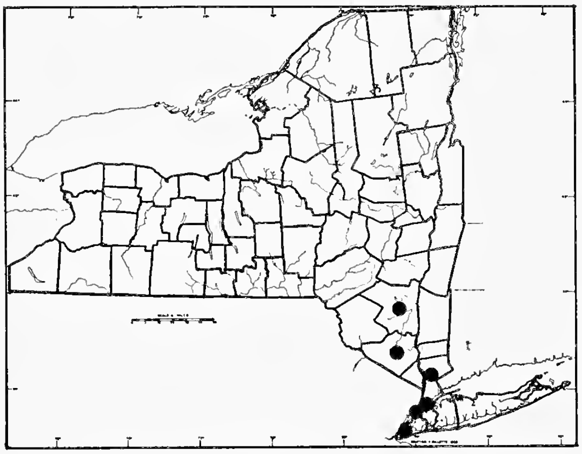
General Distribution: Maine to the Northwest Territories, south to Mexico, Louisiana and North Carolina

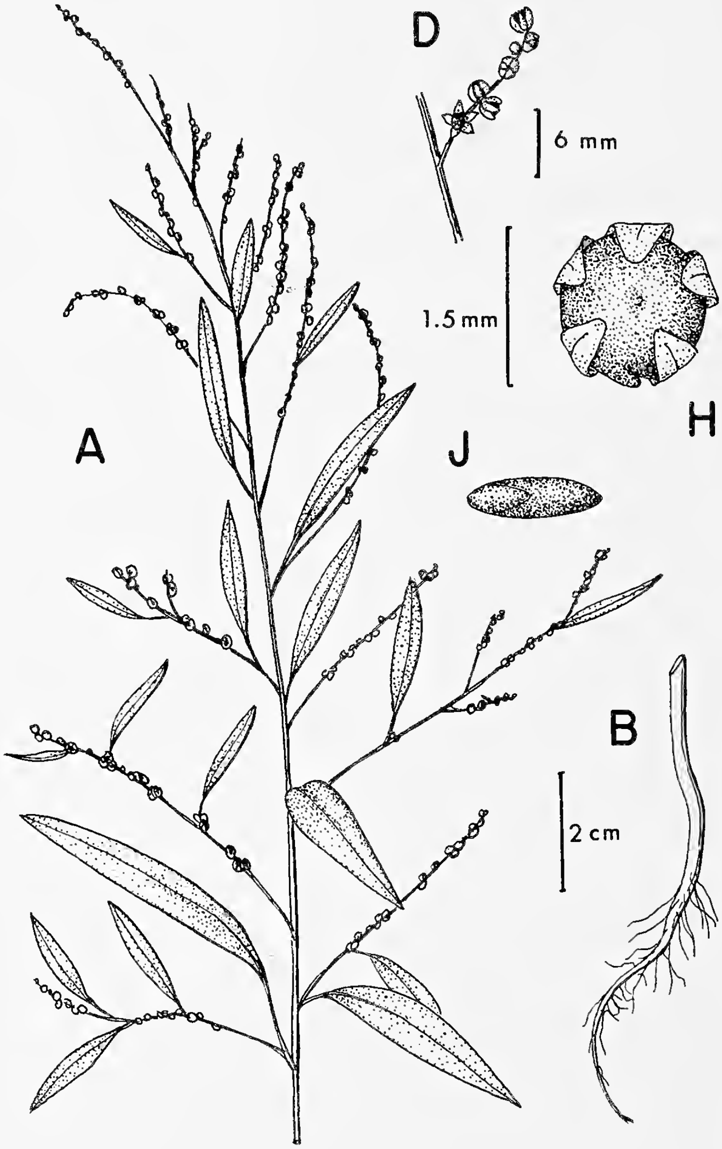
Description: Plants with **bisexual** flowers; **stigmas** 2, erect, 0.2-0.3 mm long; **style** ca. 0.1 mm long; **ovary** depressed-ovoid; **fruit** depressed-ovoid, the pericarp membranaceous, smooth, non-adherent; **seed** horizontal, black, lenticular, ovoid, 1.0-1.4 mm broad, 0.5-0.8 mm thick, testa verrucate; **stamens** 4-5; **filaments** membranaceous, 0.4-0.7 mm long; **anthers** globose, yellow, 0.2-0.3 mm long; **perianth** 4-5 lobed; **lobes** lanceolate, 0.8-1.0 mm long, 0.5-0.7 mm broad, keeled along the midvein, apex acute, densely farinose, often obscuring the seed at maturity, united at the base; **bract** linear, up to 5 mm long, or absent; **inflorescences** of terminal and axillary spikes, 1-5 cm tall, 1.5-3.5 mm broad; **glomerules** subglobose, 1.5-3.5 mm in diameter; **leaves** 3-veined, fleshy, linear, narrowly lanceolate, oblong-elliptic, or ovate-lanceolate, 1-3 cm long, 0.5-1.0 mm broad, apex acute, base cuneate, margins entire, lower surfaces densely white-mealy; **petioles** 4-10 mm long; **stems** erect to spreading, unbranched or branched from the base, 15-45 cm tall, densely farinose; **root system** annual with a taproot (2n = 18).

Note: Most New York State collections of this species are from sea beaches on Long Island. In these locations the plant is found in association with a number of indisputably native plants, including *Amaranthus pumilus* Raf. and *Atriplex arenaria* Nutt. Most authors have considered the eastern U.S. populations to be introductions but this might need to be reconsidered.

Infraspecific Variation: This is a highly variable species, whose western members have been studied by Crawford and collaborators. They recognized *C. dessicatum* as distinct from *C. pratericola* on the basis of habit and enclosure versus exposure of the mature fruit by the calyx lobes. In New York State, there are specimens that fit both species (as defined by Crawford *et al.*), but there are also apparent intermediates in one or both characteristics. *Chenopodium dessicatum* and *C. pratericola* of New York are

here treated as a single, variable species; the habit illustration depicts a plant that would fit within the morphological limits of *C. dessicatum* if both species were recognized. *Chenopodium foggii* Wahl has been reported from New York by Wahl (1954). It usually grows in relatively natural, partially shaded habitats under hardwood trees or shrubs, and this may account for the more "leggy" habit described for it. I have seen only a few sheets determined by Wahl, and these are not sufficient to prompt a suggestion as to the appropriate status of the taxon. In addition, there is confusion in the literature. Whereas, Wahl states that the pericarp of *C. foggii* is markedly separable, Bassett & Crompton (1982) say that the pericarp is adherent (an important character in their key). While the identity and relationships of *C. foggii* await further research, I am, tentatively, placing the name in synonymy under *C. pratericola*.





10. *Chenopodium standleyanum* Aellen

Common Names: Goosefoot, Standley's Goosefoot

Type Description: Aellen, Feddes Repert. Sp. Nov. Regni Veg., vol. 26, p. 153, 1929

Synonyms: *Chenopodium album* var. *boscianum* (Moq.) A. Gray; *C. boscianum* Moq. in part; *C. polyspermum* var. *spicatum* A. Gray

Origin: Native to eastern North America

Habitats: Shaded, wooded areas, often in disturbed soils

Habit: Erect, annual herbs

Flowering: August-September

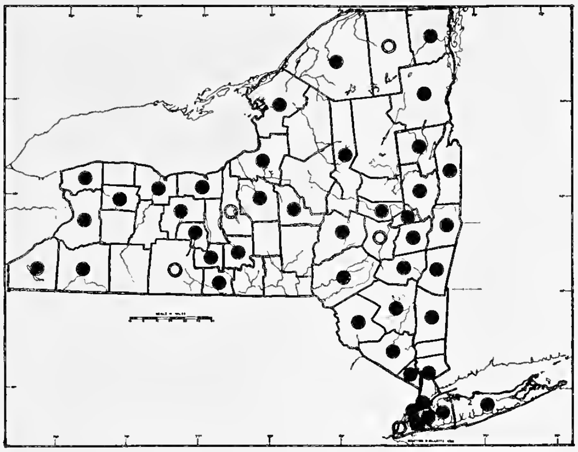
Fruiting: September

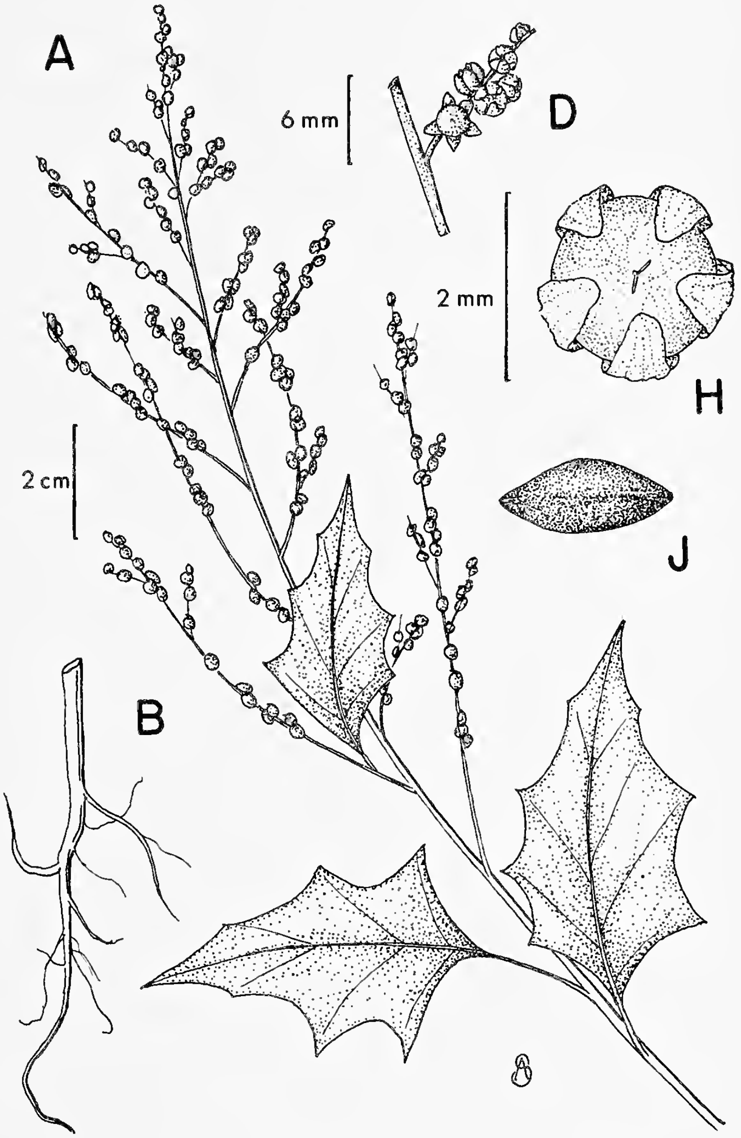
General Distribution: New York and Ontario to South Dakota, south to Texas and Florida

Rarity Status: This species is ranked G5 SH by the New York Natural Heritage Program.

Description: Plants with **bisexual** flowers; **stigmas** 2, erect or spreading, 0.1-0.2 mm long; **style** absent; **ovary** depressed-ovoid; **fruit** depressed-ovoid, pericarp membranaceous, smooth, non-adherent; **seed** horizontal, ovoid, black, lenticular, 0.9-1.3 mm in diameter, 0.6-0.8 mm thick, testa reticulate-alveolate to smooth; **stamens** 5; **filaments** membranaceous, ca. 0.3 mm long; **anthers** globose, yellow, ca. 0.1 mm long; **perianth** 5-lobed; **lobes** obovoid, 0.5-0.7 mm long, 0.5-0.7 mm broad, faintly (or not at all) abaxially keeled, apex rounded, scarcely farinose, partially covering the seed at maturity; **bract** and **bracteoles** absent; **inflorescences** terminal and axillary, flexuous spikes and panicles, 6-15 cm long, the flowers in small, widely spaced glomerules; **glomerules** irregularly globose, 0.5-2.0 mm in diameter, the flowers within them differing in stages of development; **leaves**

oblong-ovoid to lanceolate, 2.0-4.5 cm long, 0.5-1.5 cm broad, apex acute to acuminate,.base cuneate, margins entire, or with a few teeth toward the base; **petioles** 5-25 mm long; **stems** erect, branched, 20-60 cm tall, angular, glabrous; **root system** annual with a taproot (2n = 18).





11. ***Chenopodium simplex*** **(Torr.) Raf.**

Common Name: Maple-leaf Goosefoot

Type Description: Torrey, Ann. Lyceum Nat. Hist. New York, vol. 2, p. 239, 1827

Synonyms: *Chenopodium gigantospermum* Aellen, *C. hybridum* L. var. *gigantospermum* (Aellen) Rouleau, *C. hybridum* var. *simplex* Torr.

Origin: Native to eastern North America

Habitats: Woods and thickets, sometimes in waste places and in fields

Habit: Erect, annual herbs

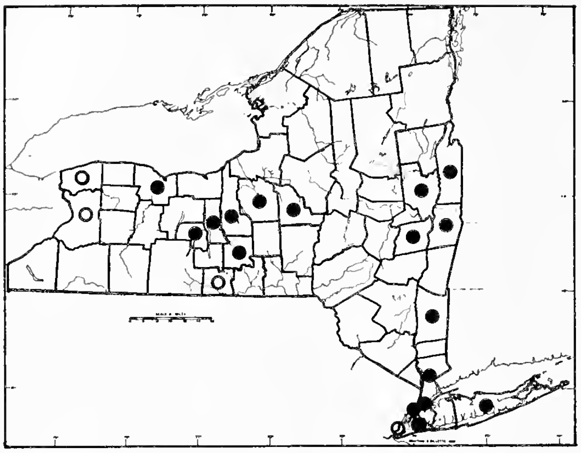
Flowering: July-October

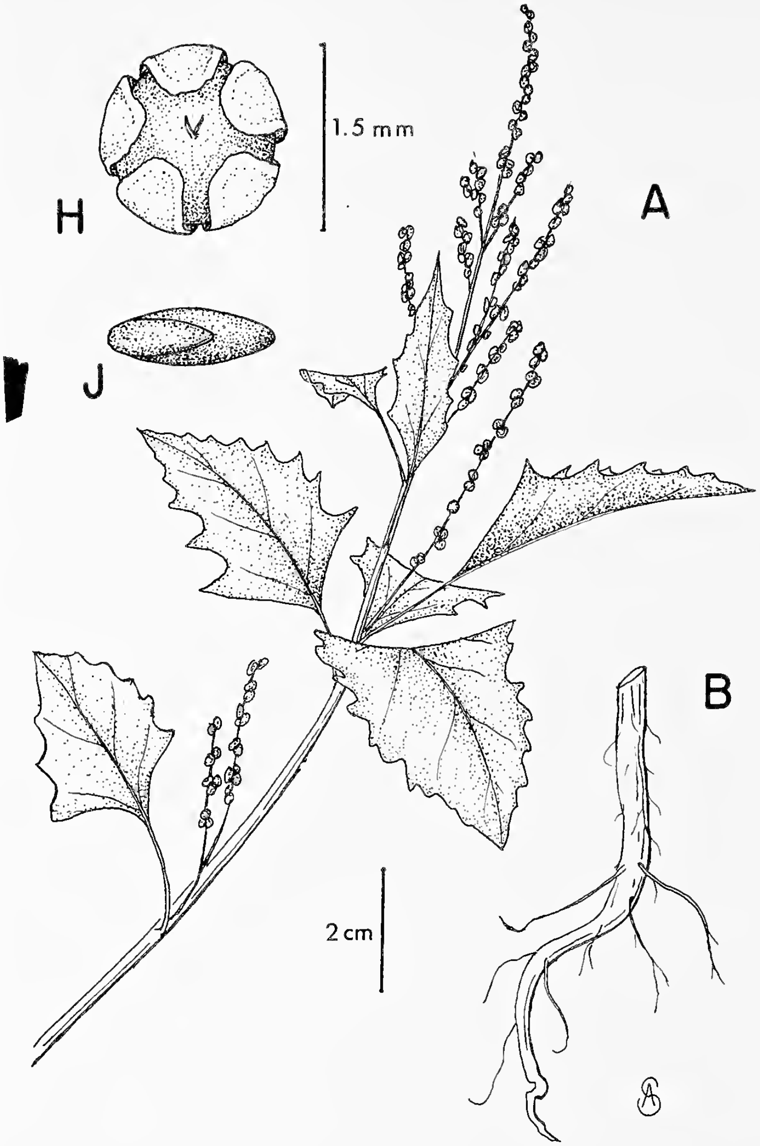
Fruiting: July-October

General Distribution: Quebec to the Northwest Territories, south to California, Texas and Virginia

Description: Plants with **bisexual** flowers; **stigmas** 2, erect or spreading, 0.1-0.2 mm long; **style** absent; **ovary** depressed-ovoid; **fruit** depressed-ovoid, the pericarp chartaceous, smooth, non-adherent; **seed** horizontal, black, lenticular, 0.9-1.0 mm high, 1.3-1.9 mm broad, testa smooth; **stamens** 5; **filaments** 0.3-0.5 mm long, membranaceous; **anthers** globose, yellow, 0.1-0.2 mm long; **perianth** 5-lobed; **lobes** fused at base, ovate to lanceolate, 0.7-1.0 mm long, 0.4-0.6 mm broad, slightly keeled abaxially, apex retuse, glabrous, margins meeting or separated by as much as their width, exposing more than half the seed at maturity; **bract** and **bracteoles** absent; **inflorescence** terminal and axillary, flexuous spikes and panicles, 6-15 cm long, the flowers in small widely spaced glomerules; **glomerules** irregularly globose, the flowers in different stages of development, 0.5-2.0 mm diameter; **leaves** ovate to triangular, 3.5-15.0 cm long, 2-9 cm broad, apex acute, base cordate to truncate, margins sinuate with 1-5 coarse acute teeth, upper leaves entire or with a few small teeth; **petioles** 1.5-4.5 mm long; **stems** erect, branched, 3-15 dm tall, grey, slightly mealy; **root system** annual with a taproot (2n = 36).

Note: This species has often been treated as part of *C. hybridum*, but typical *C. hybridum* is native to Europe and has more or less convex-lenticular, sometimes obliquely lenticular seeds with rounded margins and a foveolate-reticular surface. *Chenopodium simplex*, by contrast, has strongly convex-lenticular seeds with bluntly-keeled margins and smooth surfaces. *Chenopodium hybridum* has been reported from New York but I have seen no specimens.





12. *Chenopodium urbicum* L.

Common Name: City Goosefoot

Type Description: Linnaeus, Species Pl. I, p. 218, 1753

Origin: A native of Europe

Habitats: Waste places, especially about cities and towns, and along railroad tracks

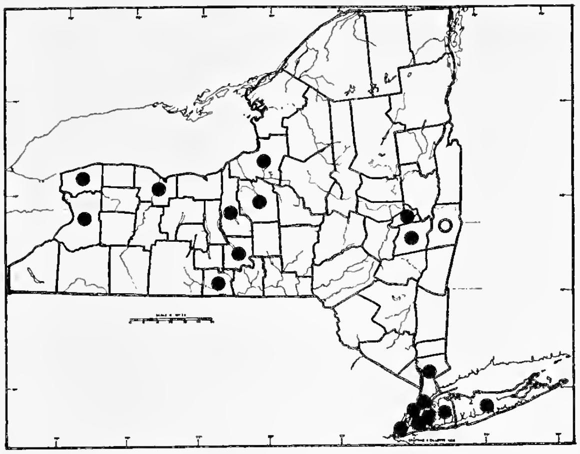
Habit: Erect, annual herbs

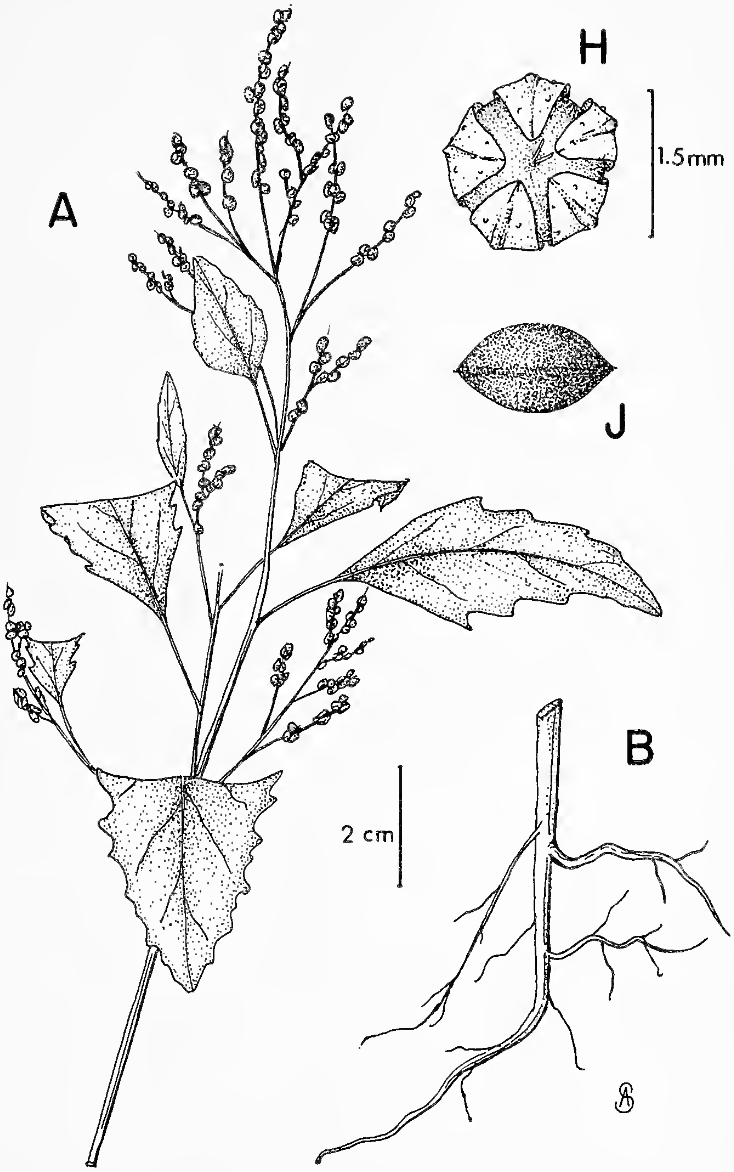
Flowering: August-September

Fruiting: August-September

General Distribution: Europe, Asia; in North America from Nova Scotia to Ontario and Wisconsin south to Missouri and Maryland

Description: Plants with **bisexual** flowers; **stigmas** 2, erect or spreading, 0.1-0.2 mm long; **style** absent; **ovary** depressed-ovoid; **fruit** depressed-ovoid, the pericarp membranaceous, papillose to smooth, non-adherent; **seed** horizontal (rarely, a few oriented vertically), black or reddish-brown, ovoid, lenticular, 0.8-1.2 mm broad, 0.5-0.6 mm thick, margin is rounded, testa rugose; **stamens** 5; **filaments** membranaceous, 0.3-0.5 mm long; **anthers** globose, yellow, 0.2-0.3 mm long; **perianth** 5-lobed; **lobes** broadly ovate to elliptic, 0.6-0.8 mm long, 0.4-0.8 mm broad, rounded or with a slight broad abaxial keel, apex obtuse, glabrous, only slightly covering the seed at maturity; **bract** and **bracteoles** absent; **inflorescences** erect, terminal panicles, and usually axillary, simple or compound spikes, 3.0-4.5 cm long, with glomerules at the nodes; **glomerules** subglobose, 2.0-3.5 mm in diameter; lower **leaves** mostly triangular, the upper triangular to lanceolate, 3-11 cm long, 3-10 cm broad, apex obtuse to acute, base truncate to cuneate, margins sinuate to dentate, often with obtuse to acute outward-pointing lobes at base; **petioles** 15-35 mm long; **stems** erect, simple or rarely branched, 3-10 dm tall, glabrous, stems angular, striated; **root system** annual with a taproot (2n = 36).





13. ***Chenopodium murale*** **L.**

Common Names: Sowbane, Nettle-leaf Goosefoot

Type Description: Linnaeus, Species Pl. I, p. 219, 1753

Origin: A native of Europe

Habitats: Waste places and along railroad tracks

Habit: Erect, annual herbs

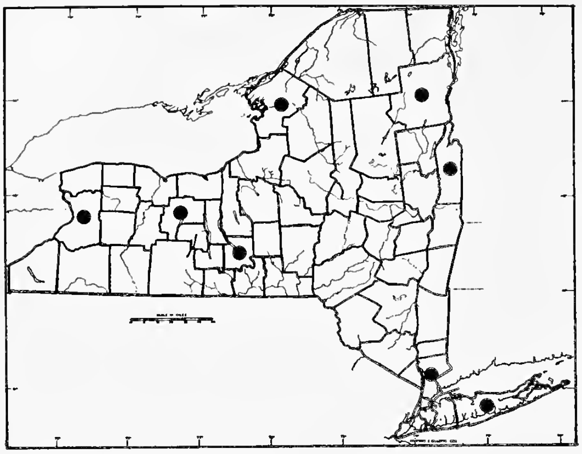
Flowering: August

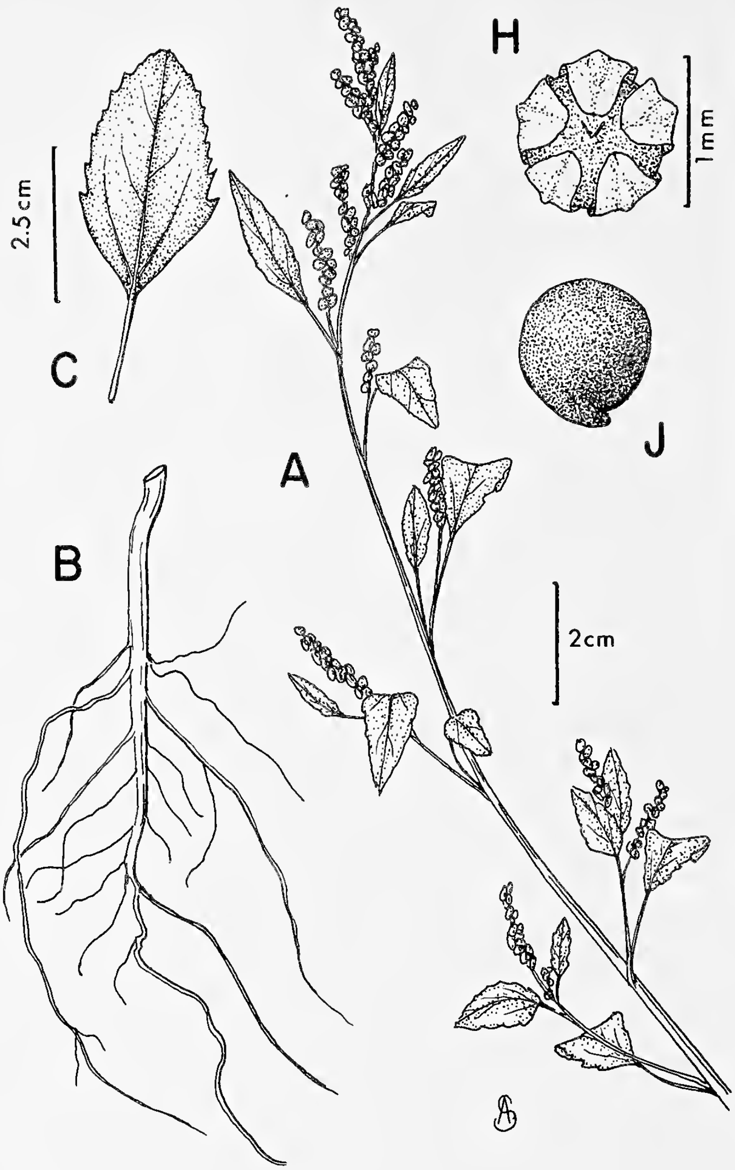
Fruiting: September-October

General Distribution: Quebec to British Columbia south to Mexico and Florida

Description: Plants with **bisexual** flowers; **stigmas** 2, erect or spreading, 0.1-0.4 mm long; **style** absent; **ovary** depressed-ovoid; **fruit** depressed-ovoid, pericarp membranaceous, pustulate, becoming smooth at maturity, adherent; **seed** horizontal, black, ovoid, lenticular, 1.1-1.5 mm in diameter, 0.6-0.8 mm thick, the margin acute, testa minutely rugose; **stamens** 5; **filaments** membranaceous, 0.5-0.7 mm long; **anthers** globose, yellow, 0.4-0.5 mm long; **perianth** 5-lobed; **lobes** ovate, 0.5-0.8 mm long, 0.6-0.7 mm broad, keeled abaxially, apex acute to obtuse, farinose, lobes covering the seed at maturity; **bract** and **bracteoles** absent; **inflorescences** terminal and axillary panicles, 6-7 cm tall, 4-5 cm broad, the flowers at each node in glomerules; **glomerules** subglobose, 2-4 mm in diameter, or the flowers not in glomerules; **leaves** rhombic-ovate, 2-4 (-8) cm long, 1-3 cm broad, apex acute to obtuse, base cuneate to subcordate, margins irregularly dentate; **petioles** 10-25 mm long; **stems** ill-scented, erect, branched, lower branches decumbent, 1-6 (-10) dm tall, glabrous to sparsely mealy; **root system** annual with a taproot (2n = 18).

Importance: The leaves and young stems are used as a salad herb.





14. *Chenopodium strictum* Roth
var. *glaucophyllum* (Aellen) Wahl

Common Name: Goosefoot

Type Description: Roth, Nov. Pl. Spec., p. 180, 1821

Origin: A native of northeastern North America

Habitats: Sunny habitats, natural clearings and disturbed ground in weedy areas

Habit: Erect, annual herbs

Flowering: August-September

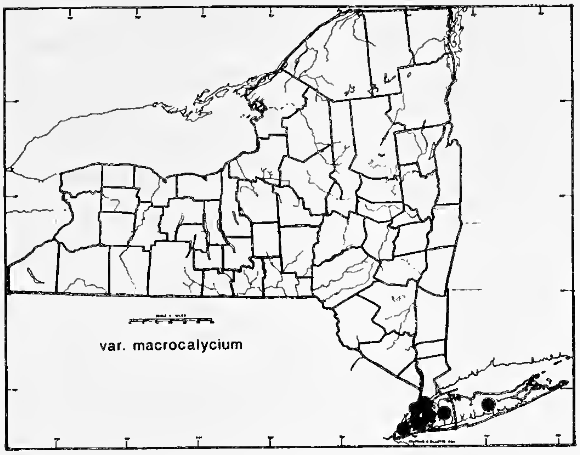
Fruiting: September-October

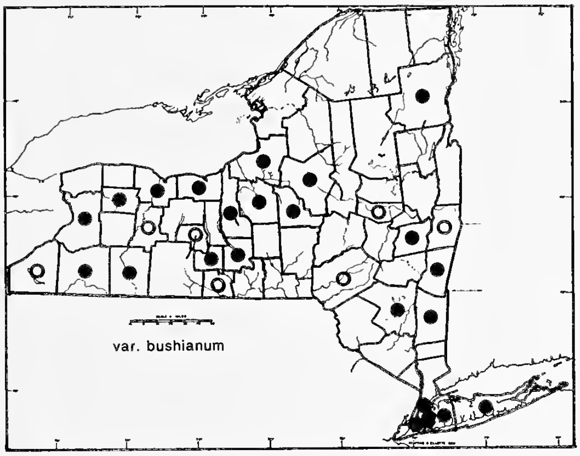
General Distribution: Prince Edward Island to British Columbia south to California, Arkansas and New York

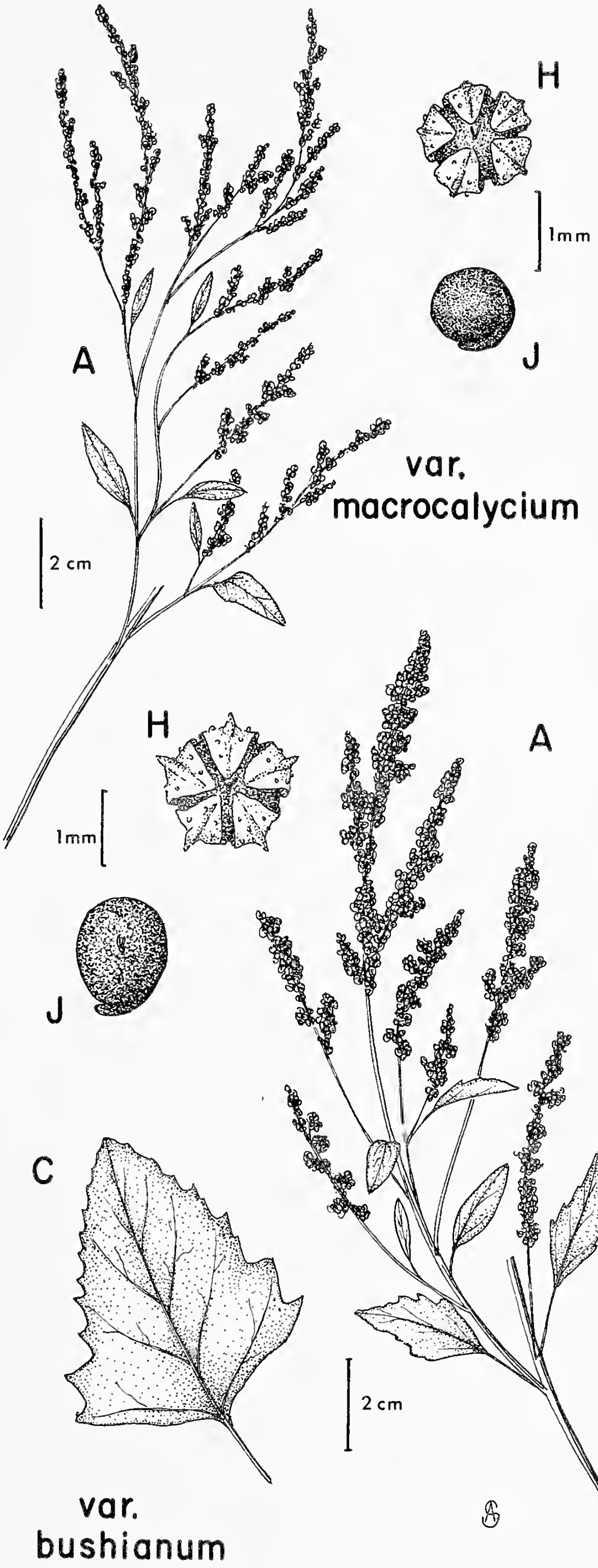
Rarity Status: This taxon is ranked G5T? S1 by the New York Natural Heritage Program.

Description: Plants with **bisexual** flowers; **stigmas** 2, erect or spreading, 0.3-0.4 mm long; **style** absent; **ovary** depressed-ovoid; **fruit** depressed-ovoid, the pericarp membranaceous, smooth, adherent; **seed** horizontal, black, oval, lenticular, 0.9-1.5 mm in diameter, 0.4-0.5 mm thick, testa smooth; **stamens** 5; **filaments** membranaceous, 0.4-0.6 mm long; **anthers** oblong, yellow, 0.2-0.3 mm long; **perianth** 5-lobed; **lobes** ovate, 0.5-0.7 mm long, 0.6-0.7 mm broad, slightly keeled on back midrib, reflexed and exposing the fruit at maturity, farinose; **bract** and **bracteoles** absent; **inflorescence** terminal spikes, 1-3 cm long, the flowers at each node in glomerules; **glomerules** globose, 1.8-2.0 mm in diameter; basal **leaves** oblong-ovate to ovate-lanceolate, 1.7-3.6 cm long, 1.0-2.8 cm broad, apex obtuse, base cuneate, margins finely serrate, upper leaves tending toward lanceolate and entire; **petiole** absent, the blades sessile; **stems** erect, branched, up to 10 dm tall, glabrous to sparsely farinose, angular, green to red striped; **root system** annual with a taproot (2n = 36).

Note: This species has often been cited under the name *C. striatum* Krašan [*C. album* ssp. *striatum* (Krašan) Murr]. That name is a synonym of *Chenopodium strictum* var. *strictum* which is native to Asia and can be recognized by the prominently serrate, oblong-ovate lower leaves which are 3 or more times longer than wide.







15. ***Chenopodium berlandieri*** **Moq.**

Common Name: Pigweed

Type Description: Moquin-Tandon, Chenop. Monogr. Enum., p. 23, 1840

Origin: A native of North America

Synonym: *Chenopodium paganum* of American Authors, not Reichenb.

Habitats: Disturbed, moist areas such as roadside ditches

Habit: Erect, annual herbs

Flowering: August-October

Fruiting: September-October

General Distribution: Throughout most of North America; introduced and naturalizing in Europe

Description: Plants with **bisexual** flowers; **stigmas** 2, erect or spreading, 0.1-0.5 mm long; **style** 0.1-0.2; **ovary** depressed-ovoid; **fruit** depressed-ovoid, pericarp membranaceous, alveolate-rugose, adherent;

seed horizontal, brown to black, ovoid, lenticular, (1.3-) 1.5-2.0 mm broad, 0.7-0.9 mm thick, testa rugose; **stamens** 5; **filaments** membranaceous, 1.0-1.2 mm long; **anthers** globose, yellow, 0.2-0.3 mm long; **perianth** 5-lobed, 2.1-2.5 mm in diameter; **lobes** ovate to deltate, 1.0-1.5 mm long, 0.9-1.3 mm broad, apex obtuse, farinose, the adaxial keel often prominent, calyx lobes enlarged, obscuring the fruit in maturity; **bract** and **bracteoles** absent; **inflorescences** erect to drooping, terminal compound spikes, 5-15 cm long; **glomerules** at the nodes, irregularly rounded, 4-7 mm in diameter; **leaves** narrowly to broadly rhombic or ovate, 1.5-8.0 (-15) cm long, 0.7-5.0 cm broad, apex acute, base cuneate to truncate, margins serrate or irregularly dentate (to entire in shade forms); **petioles** 7-70 mm long; **stems** erect to semi-erect, much-branched to simple, 2-10 dm tall, ribbed, farinose; **root system** annual with a taproot (2n = 36).

KEY TO VARIETIES

1. Style base (stylopodium) often prominent, with a small yellow area of separable pericarp; perianth lobes prominently keeled ....[*C. berlandieri var. zschackei*, a waif]
1. Style base less prominent or lacking; perianth parts usually not prominently keeled ....(2)
 2. Inflorescence large and drooping; seeds 1.5-2 mm in diameter ....15a. *C. berlandieri var. bushianum*
 2. Inflorescence small and erect; seeds 1.4-1.7 mm in diameter ....15b. *C. berlandieri var. macrocalycium*

15a. *Chenopodium berlandieri* var. *macrocalycium* (Aellen) Cronq.

Type Description: Aellen, Feddes Repert. Spec. Nov. Regni Veg. vol. 26, p. 119, 1929

Synonym: *Chenopodium macrocalycium* Aellen

Origin: Native to the Mid-Atlantic Coast of North America

Habitats: Coastal sands, beaches

Habit: Erect, annual herbs

General Distribution: Along the Atlantic coast, from Nova Scotia to North Carolina

Rarity Status: This variety is ranked G4T4 S3? by the New York Natural Heritage Program and has been placed on their watch-list

15b. *Chenopodium berlandieri* var. *bushianum* (Aellen) Cronq.

Type Description: Aellen, Feddes Repert. Spec. Nov. Regni Veg. vol. 26, p. 63, 1929

Synonyms: *Chenopodium bushianaum* Aellen, *C. paganum* Reichenb. in part.

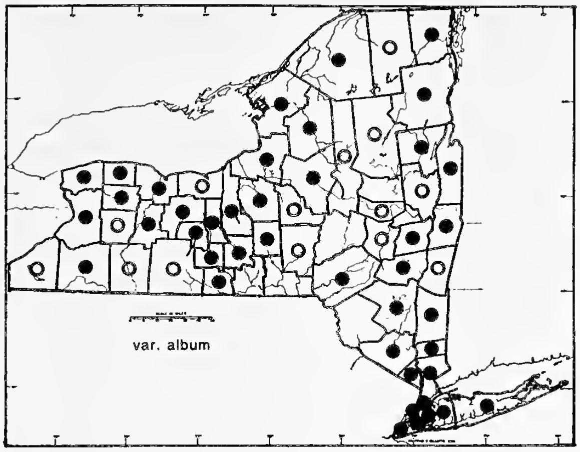
Origin: Native to northeastern North America

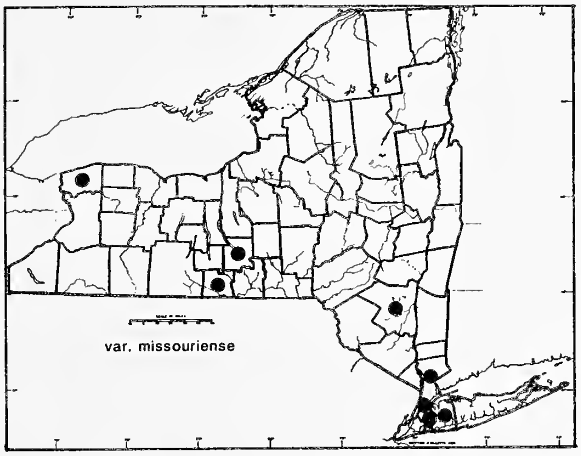
Habitats: Disturbed areas, mostly as a weed in cultivated ground

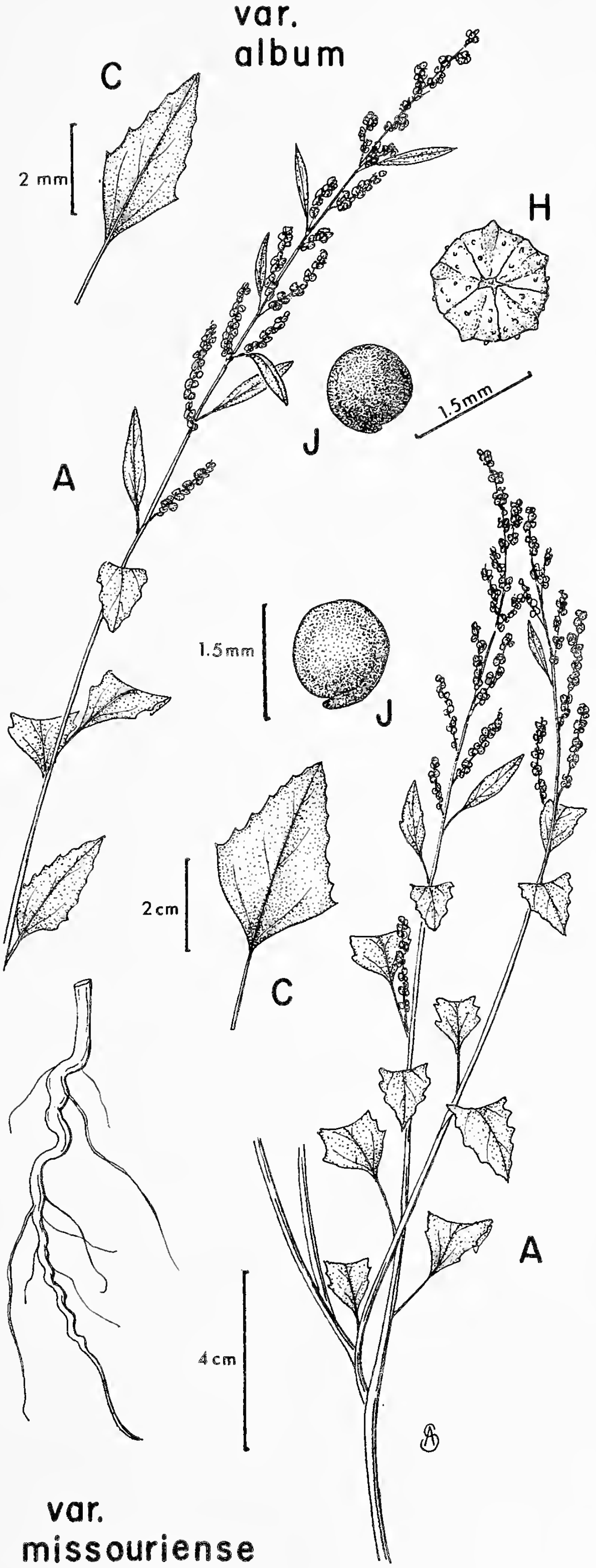
General Distribution: Quebec to Ontario south to Missouri and Virginia

Note: The related species, *Chenopodium quinoa,* Willd. may have been collected in New York City. The specimen was too young for positive identification. Quinoa is an important grain crop in the Andean Highlands of South America.

Chenopodium berlandierii var. *boscianum* (Moq.) Wahl has been reported from New York, but, true *C. berlandierii* var. *boscianum* is found only along the Gulf coast. These reports probably refer to *Chenopodium standleyanum.*







16. ***Chenopodium album*** **L.**

Common Names: Lamb's-quarters, Goosefoot, Pigweed

Type Description: Linnaeus, Species Pl. I, p. 219, 1753

Origin: A native of Eurasia that has followed man around the world

Habitats: Disturbed soils in open habitats such as roadsides, foot paths, pavement cracks, shores, gardens, meadows and lawns

Habit: Erect, annual herbs

Flowering: July-September

Fruiting: August-November

General Distribution: Cosmopolitan and ubiquitous, scattered throughout North America, except in areas of extreme desert conditions, from Newfoundland to Alaska south to Mexico

Description: Plants with **bisexual** flowers; **stigmas** 2, erect or spreading, 0.1-0.2 mm long; **style** absent;

ovary depressed-ovoid; **fruit** depressed-ovoid, the pericarp membranaceous, smooth to papillate, adherent or usually non-adherent; **seed** horizontal, black, lenticular, round in outline, 0.9-1.6 mm broad, 0.5-0.7 mm thick, testa smooth, papillose or with faint reticulate-rugose ridges; **stamens** 5; **filaments** membranaceous, 0.6-0.7 mm long; **anthers** globose, yellow, 0.3-0.4 mm long; **perianth** 5-lobed; **lobes** ovate, 0.7-1 mm long, 0.7-1.1 mm broad, the midrib keeled on back, apex obtuse, farinose, largely covering the upper half of the seed at maturity; **bract** and **bracteoles** absent; **inflorescences** terminal and axillary, compound spikes 2-19 cm long, flowers usually in glomerules at the nodes, with occasional single-flowered peduncles present; **glomerules** subglobose, 3-4 mm in diameter; **leaves** ovate-lanceolate or rhombic-lanceolate, to broadly oblong, 1.0-5.5 (-12) cm long, 0.5-3.8 (-8) cm broad, apex acute, base cuneate, margins sinuous-dentate to shallowly serrate or entire; **petioles** 1.0-2.5 cm long; **stems** erect to sprawling, simple to much-branched, 1-25 dm tall, branch tips pinkish and farinose with crowded leaf bases, the stems angular, greenish or sparsely farinose, sometimes tinged with red at maturity; **root system** annual with a taproot (2n = 36, 54).

KEY TO VARIETIES

1. Fruits 1.1-1.5 mm in diameter; flowering from mid-July onward; lower leaves more than 1.5 times longer than wide .... 16a. *C. album var. album*
1. Fruits 0.9-1.2 mm in diameter; flowering from mid-September onward; lower leaves less than 1.5 times longer than wide .... 16b. *C. album var. missouriense*

16a. *Chenopodium album* var. *album*

Synonyms: *Chenopodium album* var. *lanceolatum* (Muhl.) Coss. & Germ., *C. lanceolatum* Muhl.

Origin: A native of Eurasia

Habitats: Disturbed areas from cultivated fields to vacant lots and pavement cracks

General Distribution: Cosmopolitan; in North America from Newfoundland to Alaska south to Mexico

Variation: Whereas Bassett and Crompton (1982) considered *C. lanceolatum* to be a form of *C. album*, the two are here considered to be minor variants of the same taxon. Apparently, the differences between these two taxa are phenotypic responses to habitat, in that *C. album* grows on cultivated ground and has an erect growth habit, while *C. lanceolatum* grows in vacant lots, roadsides, etc., and has a more sprawling habit.

16b. *Chenopodium album* var. *missouriense* (Aellen) Bassett & Crompton

Type Description: Aellen, Bot. Not., p. 206, 1928

Synonyms: *Chenopodium missouriense* Aellen, *C. paganum* Reichenb. in part

Origin: Eastern-central North America

Habitats: Disturbed areas

General Distribution: New York to Ontario south to Missouri and Tennessee

Rarity Status: This taxon has been ranked G5T5 S3? by the New York Natural Heritage Program and placed on their watchlist.

Note: *Chenopodium album* is one of the more widespread and common angiosperms on earth. Several other species have often been recognized as infraspecific taxa under *C. album*, including *C. berlandieri*, *C. strictum* and their varieties. This treatment follows Bassett and Crompton (1982) in only including *C. missouriense* and *C. lanceolatum* in the complex.

Waifs: *Chenopodium aristatum* L., collected at a cotton mill, Yonkers, Westchester Co.; *Chenopodium berlandieri* var. *zschackei* (Murr) Murr; *Chenopodium fremontii* has been reported from Tompkins County; *Chenopodium foliosum* (Moench) Aschers., wool mills, Yonkers, Westchester Co. and reported from Troy (Rensselaer Co.); *Chenopodium graveolens* was reported from Onondaga Co. but no specimens have been seen; *Chenopodium opulifoilum* Schrad., probably occurred as a waif; the specimens were collected when immature; *Chenopodium polyspermum* L., Genesee, Oneida, Rensselaer Counties. and reported from Onondaga Co., not seen in over 50 years; *Chenopodium vulvaria* L., Monroe County and reported from Queens and Richmond counties, not seen in over 50 years.

Amaranthaceae (Amaranth Family)

The Amaranthaceae: a family of about 65 genera and 900 species, of nearly cosmopolitan distribution. Amaranths are particularly widespread in tropical and subtropical regions, with relatively few species in cooler climates. Amaranth/chenopod type pollen has been found as early in the fossil record as the Maestrichian Period. Several species (notably *Celosia*, *Amaranthus* and *Gomphrena*) are familiar garden ornamentals. Species of *Amaranthus* are of considerable importance as foods (pseudo-grains and pot herbs) in many parts of the world, and certain so-called "grain-amaranths" are being studied as potential crops to be grown in the United States and elsewhere for sale on the world market. *Amaranthus* species have also been extracted for dyes.

FAMILY DESCRIPTION

A family of annual or perennial herbs, often woody at the base (suffrutescent), seldom climbers, sub-shrubs, shrubs or, rarely,, small trees. The stems are erect to decumbent, trailing, or climbing, usually from a taproot. Leaves are alternate or opposite, simple and usually entire; sometimes the margin is undulate, infrequently serrulate, dentate or shallowly lobed. Petioles are long to absent, the leaf blades then sessile. Stipules are absent. The inflorescences are compact cymes or clusters arranged in axillary or terminal, simple or compound spikes, panicles, heads or rarely racemes (or flowers may be solitary). Each flower is subtended by 1 bract and usually 2 bracteoles. Bracts and bracteoles are usually scarious, often spinose, the bract being persistent, while the bracteoles either fall with the fruit or not. The flowers are small, generally regular in symmetry, bisexual or less often unisexual, sometimes aborted. Sepals are usually 4 or 5, seldom 1-3 or absent; they are free or connate, equal to subequal, imbricate, often dry and scarious or chartaceous. Stamens are as many as the sepals and opposite them, seldom fewer, their filaments distinct or, more often, connate at their bases into a tube; a nectary ring is often present within the tube base, and the tube is often toothed or lobed (with "pseudostaminodia"), alternate with the anthers. Anthers tetrasporangiate and dithecal, or, less often, bisporangiate and unithecal. The ovary is superior, 1-locular with 2-3 (-4) carpels. The style is terminal, usually solitary. Stigmas may be entire and capitate, 2-3 lobed, with segments capitate to subulate and erect or divergent, persistent. Ovules are solitary, and basal (rarely apical and pendulous), or, in a few genera, there are several ovules on a basal or short, free central placenta. The ovules are campylotropous or amphitropous, bitegmic and crassinucellar. The fruit is a dry, 1-several seeded, indehiscent, circumscissile, or irregularly dehiscent utricle or pyxis (rarely a berry or drupe). Seeds are small, mostly lenticular, subglobose to subreniform, brown to black, erect or inverted, sometimes enclosed by a small to large, bivalved aril, its testa usually shining-crustaceous. The embryo is peripheral, annular, and surrounding abundant, starchy, hard or granular perisperm. The radicle is either basal or superior. The true endosperm is nearly or quite absent. The 2 cotyledons are incumbent.

KEY TO GENERA[1]

1. Leaves alternate; flowers unisexual, the plants monoecious or dioecious .... 1. *Amaranthus*
1. Leaves opposite; flowers bisexual .... (2)
    2. Sepals connate, with long, dense hairs on the outside; inflorescences of interrupted, compound spikes, not immediately subtended by leaves; perianth tube bearing a lateral crest or spines in fruit .... 2. *Froelichia*
    2. Sepals free, glabrous; inflorescences terminal heads, or short, axillary spikes; perianth tube without lateral spines .... (3)
3. Inflorescences immediately subtended by one or more leaves . ... 3. *Gomphrena*
3. Inflorescences not subtended by leaves .... 4. *Alternanthera*

1. AMARANTHUS

Common Name: Amaranth

Authority: Linnaeus, Species pl. I, p. 989, 1753

A genus of about 90 species, now distributed nearly world-wide but best developed in the New World. Amaranths have long been used for a variety of purposes. Three species are important grain crops in the neotropics. The seeds are high in proteins, particularly those high in lysine. Seeds of the "pseudocereals" have been found in several archaeological sites in the New World and in

[1]*Celosia argentea* L., cocks-comb, is a showy garden plant, commonly cultivated in New York State, that may occasionally escape, but no specimens or records of this have been seen. Members of this genus have several seeds per ovary and alternate leaves.

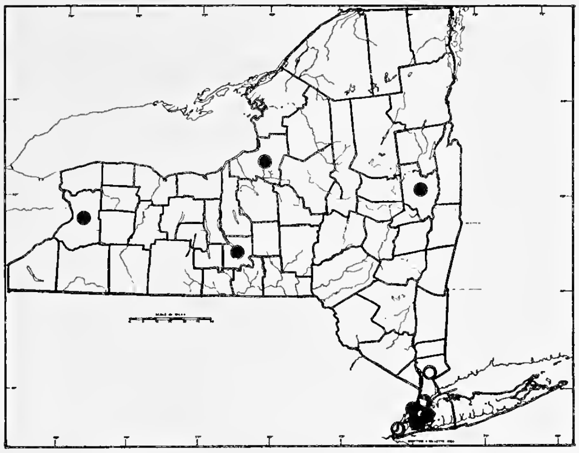
Europe, and they may have been among the earliest plants domesticated by man. Many species are also used as pot herbs and vegetables. A few species with highly-pigmented foliage and flowers are used as ornamentals and dye plants. Several amaranths are noxious weeds, and a few species are known to concentrate nitrates and become poisonous to livestock.

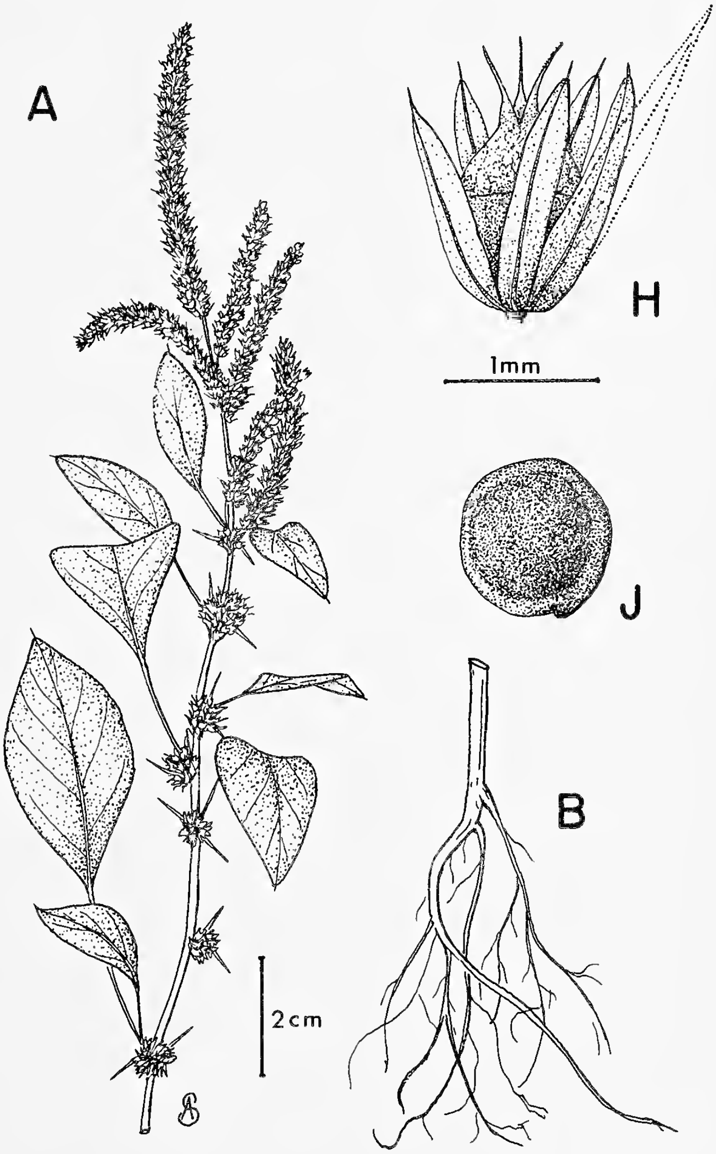
Description: Plants with **unisexual** flowers, either **monoecious** or **dioecious**; **stigmas** 2-4, subulate, papillose, sometimes interpreted as style branches; **style** 1 or absent; **ovary** 1, ovoid, absent in staminate flowers, unilocular; **ovule** 1, basally attached, erect, the micropyle inferior, funiculus short; **fruit** a circumscissile, irregularly-dehiscent, or indehiscent utricle, pericarp membranaceous; **seed** 1, vertical, lenticular to subglobose; **embryo** coiled in a ring around the perisperm; **perisperm** mealy; **radicle** basal; **stamens** 3-5, hypogynous, absent in female flowers; **filaments** free to the base, linear, opposite sepals; **anthers** bisporangiate, dorsifixed, introrse; **perianth** of 3-5 sepals, absent or rudimentary in carpellate flowers; **sepals** distinct, membranaceous, subequal or the outer exceeding the inner, glabrous, the midrib faint to broad, usually excurrent and often spinose; **peduncles** usually very short, the glomerules subsessile; **bracts** lanceolate; **bracteoles** 2; **inflorescences** terminal and axillary spikes or compound spikes, or the flowers in axillary glomerules; **glomerules** unisexual or bisexual, when bisexual the first (terminal) flower is male and succeeding flowers are female; **leaves** simple, alternate, entire or undulate, rhombic, lanceolate, ovate, oblanceolate, obovate, or rarely spatulate and emarginate, sometimes somewhat fleshy, green to reddish or yellowish, the midrib often excurrent and sometimes spinose; **petioles** usually elongate; **stipules** absent but spines sometimes replacing them at leaf bases; **stems** herbaceous to suffrutescent, erect, ascending, or infrequently decumbent, simple or much-branched from the base, sometimes striate or fleshy, green to reddish or whitish, borne on a stout, annual **taproot** or rarely a perennial **rootstalk**.

KEY TO SPECIES

1. Plants with spines at leaf bases; terminal spikes with male flowers at apex and female flowers at base .... 1. *A. spinosus*
1. Plants without spines at leaf bases; terminal spikes (if present) either all one sex or with scattered male and female flowers .... (2)
   2. Plants dioecious; inflorescences terminal only; perianth of female flowers usually with 0-2 sepals .... (3)
   2. Plants monoecious; inflorescences terminal or axillary; perianth of female flowers with 3-5 sepals .... (10)
3. Plant pistillate .... (4)
3. Plant staminate .... (7)
   4. Fruit indehiscent; sepals lacking or sporadically present and rudimentary, less than 1 mm long, without visible midveins (5)
   4. Fruit circumscissile; sepals regularly present, at least 1 mm long, with distinct midveins .... (6)
5. Seeds 1.9-3.0 mm long; utricle 2.2-3.5 (-4) mm long; leaf-blades usually narrowly lanceolate to linear .... 2. *A. cannabinus*
5. Seeds 0.8-1.2 mm long; utricle 1.0-2.3 mm long; leaf-blades usually broadly lanceolate .... 3. *A. tuberculatus*
   6. Sepals 1-2 (-3), lanceolate to linear .... 4. *A. rudis*
   6. Sepals 5, the inner ones spatulate .... [*A. palmeri*, a waif]
7. Outer sepals (of male flowers) without heavy midveins, not appreciably longer than the inner sepals; bracts mostly with slender midribs, 0.6-1.5 mm long .... (8)
7. Outer sepals with heavy midveins, often longer than the inner ones; bracts with heavy midribs, 1-4 mm long .... (9)
   8. Bract 0.6-1.3 mm long, the midrib scarcely excurrent .... 2. *A. cannabinus*
   8. Bract 1.0-1.5 mm long, the midrib conspicuously excurrent .... 3. *A. tuberculatus*
9. Bract 1.0-1.5 mm long, shorter than outer sepals .... 4. *A. rudis*
9. Bract about (2.5-) 3-4 mm long, equalling or longer than the outer sepals .... [*A. palmeri*, a waif]
   10. Inflorescence composed of axillary glomerules only .... (11)
   10. Inflorescence with long, terminal panicle, occasionally with axillary glomerules .... (14)
11. Bracteoles twice as long as the female perianth; sepals of female flowers 3 .... 5. *A. albus*
11. Bracteoles shorter than, or equal to, the female perianth; sepals of female flowers 4-5 .... (12)
   12. Fruits circumscissile, smooth; leaves neither crisped nor fleshy .... 6. *A. blitoides*
   12. Fruits indehiscent, rugose; leaves conspicuously crisped or fleshy .... (13)
13. Leaves rhomboid to obovoid, crisped, not fleshy; fruits 1.5- 2.0 mm long .... 7. *A. crispus*
13. Leaves obovoid to suborbicular, fleshy, not crisped; fruits 2.5-4.0 mm long .... 8. *A. pumilus*
   14. Fruits indehiscent; sepals of female flowers 3 .... (15)
   14. Fruits circumscissile; sepals of female flowers 3-5 .... (17)
15. Leaves emarginate or subtruncate; fruits smooth .... 9. *A. blitum*
15. Leaves acute; fruits smooth or muricate .... (16)
   16. Fruits muricate, shorter than to about equaling the perianth .... [*A. viridis*, a waif]
   16. Fruits smooth or slightly wrinkled, ca. twice as long as the perianth .... [*A. deflexus*, a waif]

17. Bracts longer than the fruit; seeds dark brown to black, common weeds ....(18)
17. Bracts shorter than the utricle; seeds usually pale ivory to reddish brown; rare escapes from cultivation ....(20)
18. Sepals all retuse or obtuse; inflorescence branches short and thick, often spreading ....10. *A. retroflexus*
18. Sepals (at least the outer ones) acute to acuminate; inflorescence branches long or slender or both, often ascending ...(19)
19. Bract about 5 mm long, with a very heavy midrib; stigmas thick at base; sepals and stamens 3-5 ....11. *A. powellii*
19. Bract 3-4 mm long, with moderately heavy midrib; stigmas slender at base; sepals and stamens 5 ....12. *A. hybridus*
20. Inflorescence stiff; bract equalling stigmas, with a moderately heavy midrib; stigmas thick at base ...13. *A. hypochondriacus*
20. Inflorescence lax; bract not equalling the stigmas or exceeding utricle, with slender midrib; stigmas slender at base ..(21)
21. Sepals straight, the inner one oblong, subacute; stigmas erect ....14. *A. cruentus*
21. Sepals recurved, the inner ones spatulate, obtuse or emarginate; stigmas spreading ....15. *A. caudatus*





1. ***Amaranthus spinosus*** **L.**

Common Names: Spiny Amaranth, Thorny Amaranth

Type Description: Linnaeus, Species Pl. II, p. 991, 1753

Origin: Native to tropical America

Habitats: Waste areas, dumping grounds, ballast heaps

Habit: Erect, annual herbs

Flowering: July-August

Fruiting: August-September

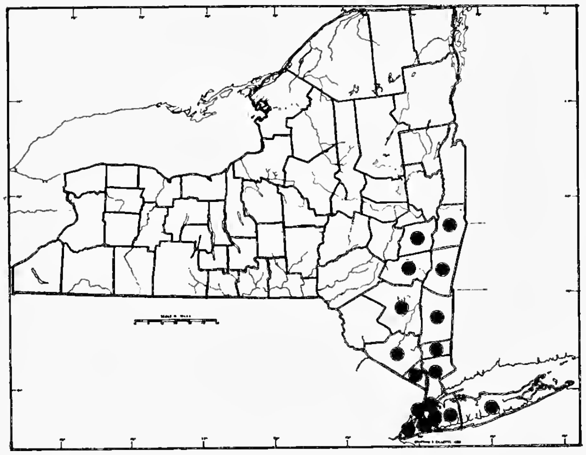
General Distribution: Widespread in the tropics, and introduced in temperate areas; in North America: southern Ontario to southern Manitoba south to Florida and Mexico

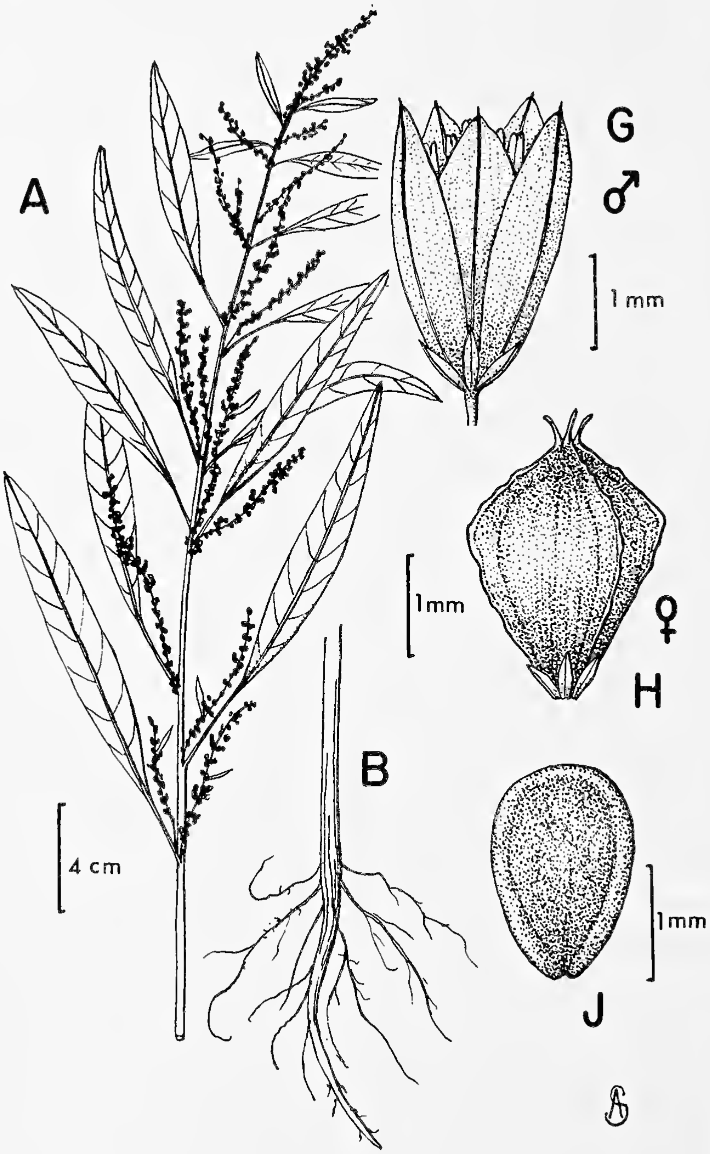
Description: Plants **monoecious; female flowers: stigmas** 3, erect, 0.4-1.3 mm long; **style** absent; **fruit** dry, circumscissile (rarely indehiscent or irregularly bursting), ovoid to ellipsoid, 1.5-2.0 mm long, 0.7-1.0 mm broad, smooth above, wrinkled below, stramineous; **seed** black to dark reddish-brown, lenticular, round in outline, 0.7-1.0 mm in diameter, 0.5-0.6 mm thick, testa smooth; **sepals** 5, oblong, obtuse to acute, 1-nerved, nerve excurrent, 1.0-1.7 mm long, 0.6-0.7 mm broad; **bracts** ovate to lanceolate or subulate, 0.5-3.0 mm long, 0.2-1.1 mm broad, tapering to a stout, subulate green tip; **male flowers: stamens** 5; **filaments** membranaceous, 1.5-2.1 mm long; **anthers** ellipsoid, light yellow to reddish, 0.6-1.3 mm long; **sepals** 5, lance-oblong, acute to acumi-

nate, the outer sepals subulate-tipped, 1.0-2.1 mm long, 0.6-0.7 mm broad; **bracts** ovate to lanceolate, 0.8-2.5 mm long, 0.5-0.8 mm broad, spinose-tipped; **bracteoles** ovate, 0.7-0.9 mm long, 0.4-0.5 mm wide; **inflorescences** terminal and axillary, erect or drooping, leafless spikes, 3-8 cm long, 5-7 mm broad; **glomerules** unisexual, sessile, the pistillate glomerules in leaf axil or at the proximal nodes of spikes, 0.7-1.0 mm in diameter, staminate glomerules at the distal nodes of the spikes, 0.7-1.1 cm in diameter; **leaves** ovate to ovate-lanceolate or rhombic-ovate, 1.5-5.5 (12) cm long, 0.5-3.2 cm broad, apex obtuse, broadly rounded or emarginate, spinose mucronate, base broadly cuneate, surfaces glabrous to sparingly pubescent; **petioles** slender, 0.5-5.0 (-9) cm long, often pubescent, bearing in the axil 2 rigid, sharp-pointed spines, 2-11 (-25) mm long; **stems** stout, succulent, erect or ascending, 2.5-6.5 (-12) dm tall, sulcate, often reddish, glabrous below, more or less pubescent above; **root system** annual, with a taproot that is sometimes branched (2n = 34).

Infraspecific Variation: Several minor variants have been named, based on presence of spines and color of the inflorescence. None of these occur in New York State.

Importance: Young, soft-spined plants are sometimes eaten as a pot herb. In Latin America a decoction of the plants is used as a remedy for rheumatism and bladder inflammations, taken as an emmenagogue, used for bathing to allay fever and applied to external inflammations. The crushed or lightly cooked leaves may serve as a poultice. A root decoction is also taken as a diuretic and for bladder distress.





2. ***Amaranthus cannabinus*** **(L.) Sauer**

Common Name: Salt-marsh Water-hemp

Type Description: Linnaeus, Species Pl. II, p. 1027, 1753

Synonyms: *Acnida cannabina* L., *A. cannabina* var. *lanceolata* Moq. in DC., *A. cannabina* var. *salicifolia* (Raf.) Moq. in DC., *A. elliotii* Raf., *A. obtusifolia* Raf., *A. rusocarpa* Michx., *A. rhyssocarpa* Spreng., *A. salicifolia* Raf., *Amaranthus macrocaulos* Poir.

Origin: A native of eastern North America

Habitats: Tidal mudflats, marshes, swamps and river banks, most common in sandy places from fresh to salt water shores

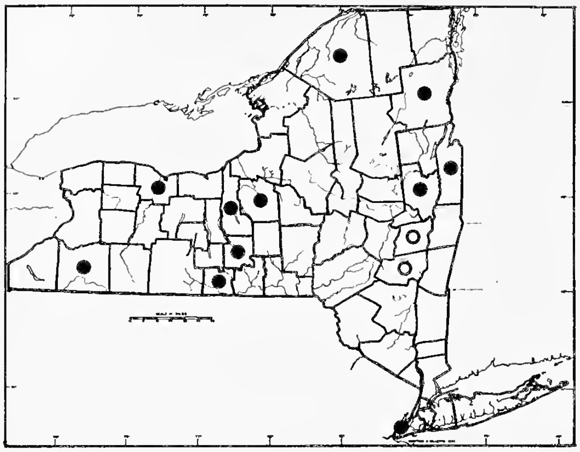
Habit: Erect, slightly succulent, annual herbs

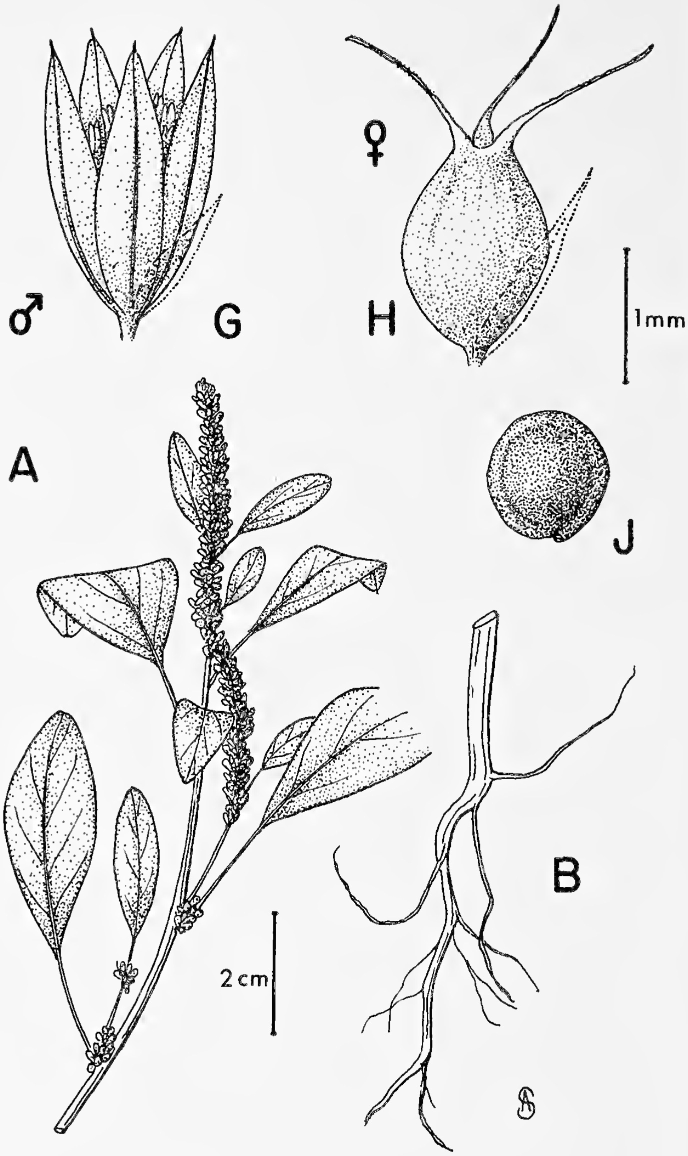
Flowering: July-September

Fruiting: July-late October

General Distribution: Atlantic Coast from Maine to northeastern Florida and inland along tidal waterways (Hudson River)

Description: Plants **dioecious**; **female flowers**: **stigmas** 3-5, erect to spreading, 0.7-1.2 mm long; **style** absent; **fruit** fleshy, indehiscent, ovoid to turbinate, 2.2-3.5 (-4) mm long, 2.4-3.5 mm broad, with 3-5 prominent, dentate or tuberculate, longitudinal ridges corresponding with the stigmas, green when young, often becoming rugose and black when mature; **seed** dark reddish-brown, obovoid to ellipsoid, flattened with a depressed endosperm, 1.9-3.0 mm in diameter, 0.9-1.1 mm thick, testa minutely granulate to nearly smooth; **sepals** usually absent, rarely 1-2, irregular, 0.6-1.0 mm long, 0.3-0.4 mm broad; **bracts** lanceolate to ovate or oblong, 1.2-1.6 (-2.2) mm long, 0.4-0.5 mm broad, acute, midrib moderately heavy, scarcely excurrent; **male flowers**: **stamens** 5; **filaments** membranaceous, 1.5-1.6 mm long; **anthers** ellipsoid, light yellow, 1.0-1.5 mm long; **sepals** 5, oblong, 1.9-3.0 mm long, 0.8-1.0 mm broad, the inner ones emarginate, the outer acute, membranaceous with a narrow, excurrent midvein; **bracts** lanceolate, 0.6-1.3 mm long, 0.4-0.8 mm broad, midrib very slender, scarcely excurrent; **female inflorescences** terminal and axillary, often flexuous, leafy or leafless spikes, 5-20 cm long, 5-10 mm broad (occasionally glomerules are found in leaf axils); **male inflorescences** terminal and axillary, leafless, spikes 4-15 cm long, 5-7 mm broad, glomerules occasionally clustered in leaf axils; **glomerules** unisexual, sessile, pistillate glomerules often spaced along the rachis, 0.6-1.0 cm in diameter, usually with reduced leaves subtending basal glomerules, staminate glomerules usually densely clustered on the rachis, 0.5-0.6 cm in diameter; **leaves** narrowly lanceolate to linear, 5-15 cm long, 1-2 (-3) cm wide, apex long-attenuate or acuminate, with a rounded or obtuse tip, acute to attenuate at the base, glabrous to minutely tomentose; **petioles** slender, 1.5-5.5 cm long, glabrous to minutely tomentose; **stems** stout, erect, 3-30 dm tall, often enlarged at the base, smooth or sulcate, green, with ascending branches; **root system** annual with a short, thick taproot and fibrous lateral rootlets.





3. ***Amaranthus tuberculatus*** **(Moq. ex DC.) Sauer**

Common Names: Rough-fruited Water-hemp, Tall Water-hemp

Type Description: DeCandolle, Prodr. 13(2): 277, 1849

Synonyms: *Acnida altissima* (Ridd.) Moq. ex Standl., *A. subnuda* (S. Wats.) Standley, *A. tamariscina* var. *prostrata* Uline & Bray, *A. tamariscina* var. *subnuda* Coult., *A. tuberculata* Moq. ex DC., *A. cannabina* L. var. *concatenata* Moq., *Amaranthus altissimus* Riddell, *Montelia tamariscina* (Nutt.) A. Gray

Origin: Native to central North America

Habitats: Exposed margins of rivers, creeks, lakes, ponds, marshes, and bogs or artificially disturbed areas, such as roadside ditches, fields and gardens

Habit: Prostrate to erect, succulent, annual herbs

Flowering: July-August

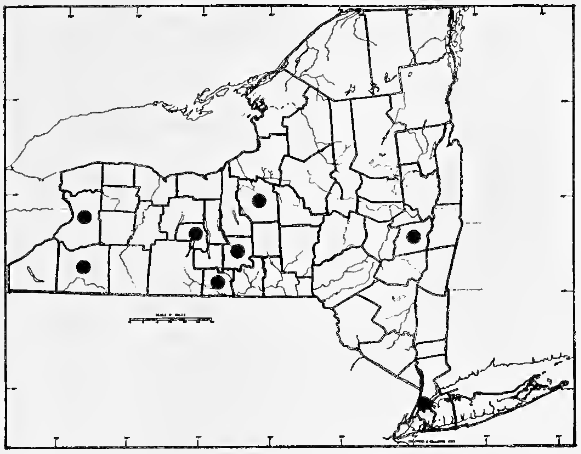
Fruiting: August-September

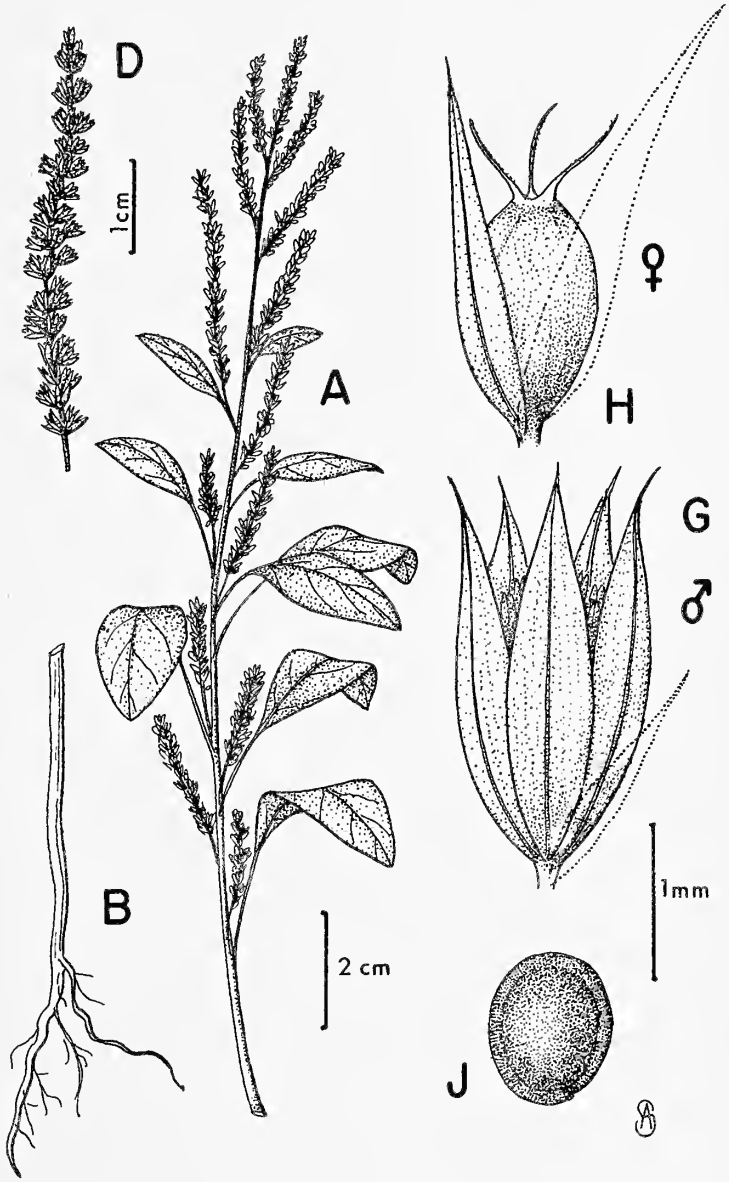
General Distribution: Vermont and Connecticut west to North Dakota south to Nebraska, Tennessee and Louisiana

Description: Plants **dioecious**; **female flowers: stigmas** 2-4, erect or spreading, 0.6-1.0 mm long; **style** absent; **fruit** dry, indehiscent or irregularly bursting, globose to ovoid, 1.0-2.3 mm long, 0.6-1.0 mm broad, sometimes with faint ridges corresponding to the stigmas, smooth or irregularly tuberculate, often reddish; **seed** dark reddish-brown to black, lenticular, round or obovoid in outline, 0.6-1.0 mm in diameter, 0.5-0.6 mm thick, testa smooth; **sepals** usually absent, occasionally 1-2, irregular, rudimentary, 0.6-1.0 mm long, 0.2-0.4 mm broad; **bracts** lanceolate or subulate, 1.2-1.6 mm long, 0.3-0.6 mm broad, acuminate to attenuate, midrib excurrent far beyond the lamina tip as a rigid, sharp point; **male flowers: stamens** 5; **filaments** membranaceous, 1.0-1.2 mm long; **anthers** ellipsoid, yellow, 1.1-1.5 mm long; **sepals** 5, oblong to ovate, 2.5-3.0 mm long, 0.5-0.7 mm broad, the inner ones obtuse or emarginate, the outer acuminate, midveins narrow, excurrent; **bracts** 1.0-1.5 mm long, 0.4-0.6 mm broad, midrib very slender, excurrent; **female inflorescences** terminal and axillary, usually leafy spikes, 2-10 cm long, 5-10 mm broad (occasionally glomerules are found in leaf axils); **male inflorescences** terminal and axillary spikes, 3-14 cm long, 4-12 mm broad, and occasional glomerules clustered in the axil of leaves; **glomerules** unisexual, sessile, the pistillate ones usually spaced along rachis without reduced leaves, the staminate ones usually densely clustered; **leaves** glabrous, the blades extremely variable in size and shape, broadly ovate to lanceolate or the uppermost lance-linear, 1-15 cm long, 0.5-5 cm wide, apex usually acute to acuminate,

sometimes obtuse, narrowed toward the obtuse, often emarginate tip, the base obtuse or cuneate; **petioles** slender, 1-7 cm long, glabrous; **stems** stout, prostrate, ascending or erect, 1-30 dm tall, smooth or sulcate, green or tinged with red, with ascending branches; **root system** annual with a long, thin, often branched taproot (2n = 32, 64).

Infraspecific Variation: Prostrate plants with small, spatulate leaves and poorly developed inflorescences (thyrses) have been separated as var. *prostrata* Uline & Bray. This variety is, apparently, merely a late-autumn form of the typical variety, not a genotypically distinct entity (Sauer, 1955).





4. ***Amaranthus rudis*** **Sauer**

Common Name: Water-hemp

Type Description: Sauer, Madroño, vol. 21, p. 428, 1972

Synonyms: *Acnida tamariscinus* Nutt., *Amaranthus tamariscinus* (Nutt.) Wood

Origin: Native to central North America

Habitats: Margins: river floodplains, streambanks, sandbars, muddy lakeshores, edges of ponds and marshes; weedy on roadsides, railroad right-of-ways, and in fields and gardens

Habit: Erect, annual herbs

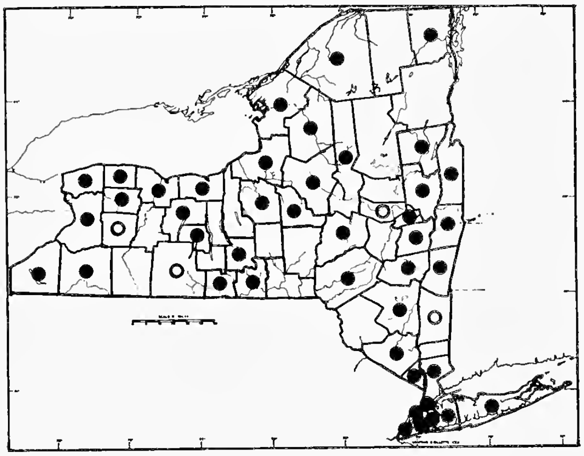
Flowering: August

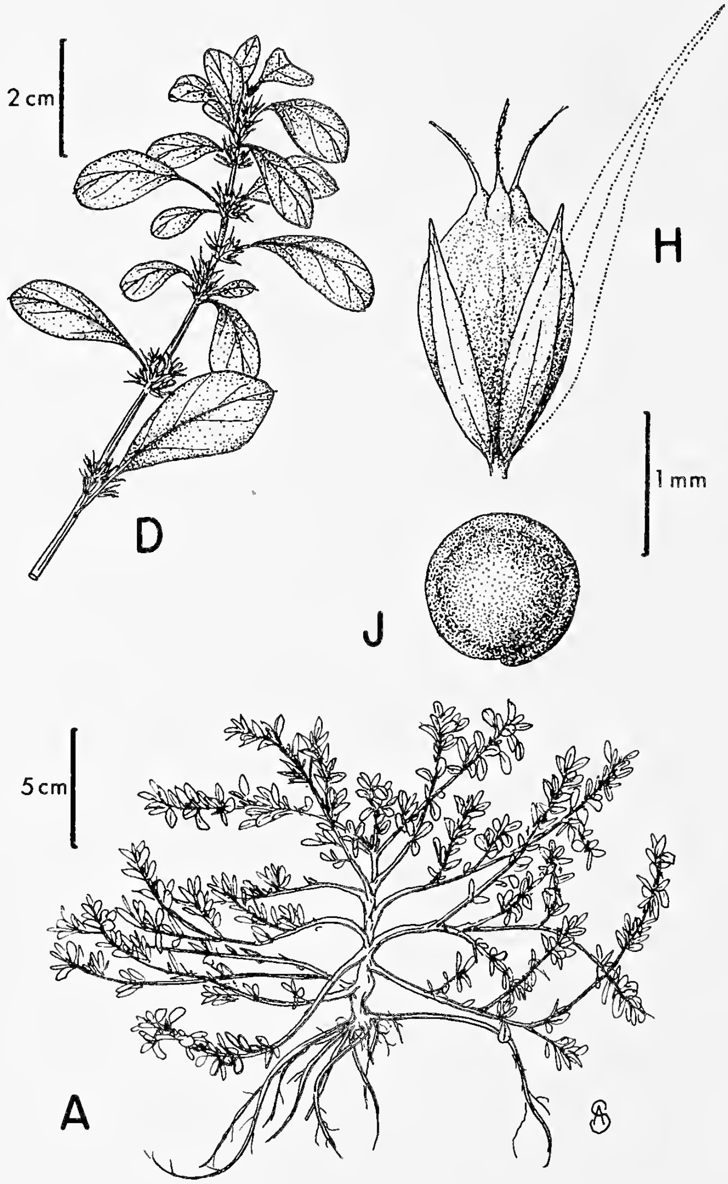
Fruiting: August-October

General Distribution: Native from Wisconsin to North Dakota south to Texas and Louisiana, widely introduced *i.e.*: West Virginia, California, New York; also naturalized in Eurasia

Description: Plants **dioecious**; **female flowers**: **stigmas** 3-4, erect to spreading, 0.8-1.0 mm long; **style** absent; **fruit** dry, circumscissile, globose to ovoid, 1.2-1.6 mm long, 0.9-1.1 mm broad, smooth to rugose or tuberculate, sometimes with faint ridges of tubercles corresponding to the stigmas, often reddish; **seed** dark reddish-brown to black, lenticular, round in outline, 0.9-1.1 mm in diameter, 0.4-0.5 mm thick, testa smooth; **sepals** 1-2 (-3) the shorter sepal rudimentary, 0.3-1.0 mm long, ca. 0.3 mm broad, the longer narrowly lanceolate, acuminate, midvein sometimes branched, excurrent, 1.3-2.0 mm long, 0.3-0.4 mm broad; **bracts** linear to lanceolate, 1.8-2.2 mm long, 0.3-0.5 mm broad, attenuate with a stout, excurrent midrib; **male flowers: stamens**

5; **filaments** membranaceous, 1.2-2.5 mm long; **anthers** ellipsoid, yellow, 1.5-1.7 mm long; **sepals** 5, oblong to ovate, inner sepals 2.2-2.5 mm long, 0.6-0.7 mm broad, obtuse or emarginate, outer sepals 2.6-3.1 mm long, 0.6-0.8 mm broad, acuminate, with a conspicuous, excurrent midvein; **bracts** lanceolate, 1.0-1.5 mm long, 0.2-0.6 mm broad, with moderately heavy, excurrent midrib; **female inflorescences** terminal and axillary, usually leafy spikes, 3-40 cm long, 6-15 mm broad; **male inflorescences** terminal and axillary, usually leafy spikes, 5-20 cm long, 8-10 mm broad; **glomerules** unisexual, sessile, 3-5 mm broad; **leaves** oblong to lance-oblong, sometimes lanceolate or ovate, 1-10 cm long, 0.4-3.5 cm broad, rounded or obtuse at the apex, acute to attenuate at the base, upper leaves much-reduced and narrowly oblong, glabrous; **petiole** slender, 0.6-5.0 cm long, glabrous; **stems** stout, erect or ascending, 5-20 dm tall, striate-angulate or smooth, green or glaucescent, unbranched, or usually with ascending branches, glabrous or nearly so; **root system** annual with taproot (2n = 32, 48).





5. *Amaranthus albus* L.

Common Names: Tumbleweed, Tumbleweed-amaranth

Type Description: Linnaeus, Syst. Nat., ed. 10, II, p. 1268, 1759

Synonym: *Amaranthus graecizans* of American authors *pro parte*, not L.

Origin: Native to central North America

Habitats: Fields, roadsides, along railroad tracks, weedy in waste areas and rarely naturalized along shores; in its native range also in dry prairies and stream valleys

Habit: Erect, annual herbs

Flowering: June-August

Fruiting: August-October

General Distribution: Nova Scotia to British Colombia south to Mexico; adventive in eastern North America, Europe, Asia, Africa and South America

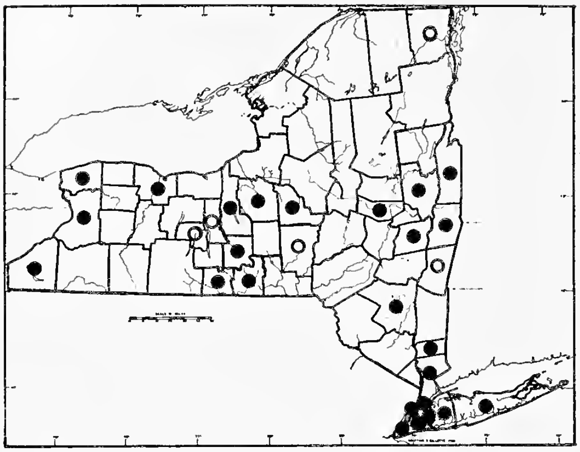
Description: Plants **monoecious**; **female flowers: stigmas** 3, erect, 0.4-0.7 mm long, swollen at base; **style** absent; **fruit** dry, circumscissile, obovoid to subglobose, often with transverse ridges near the septum, 0.9-1.5 mm long, 0.9-1.1 (-1.3) mm broad, rugose, stramineous to dark, gray-brown, sometimes tinged with red; **seed** dark reddish-brown, lenticular, round in outline, 0.8-

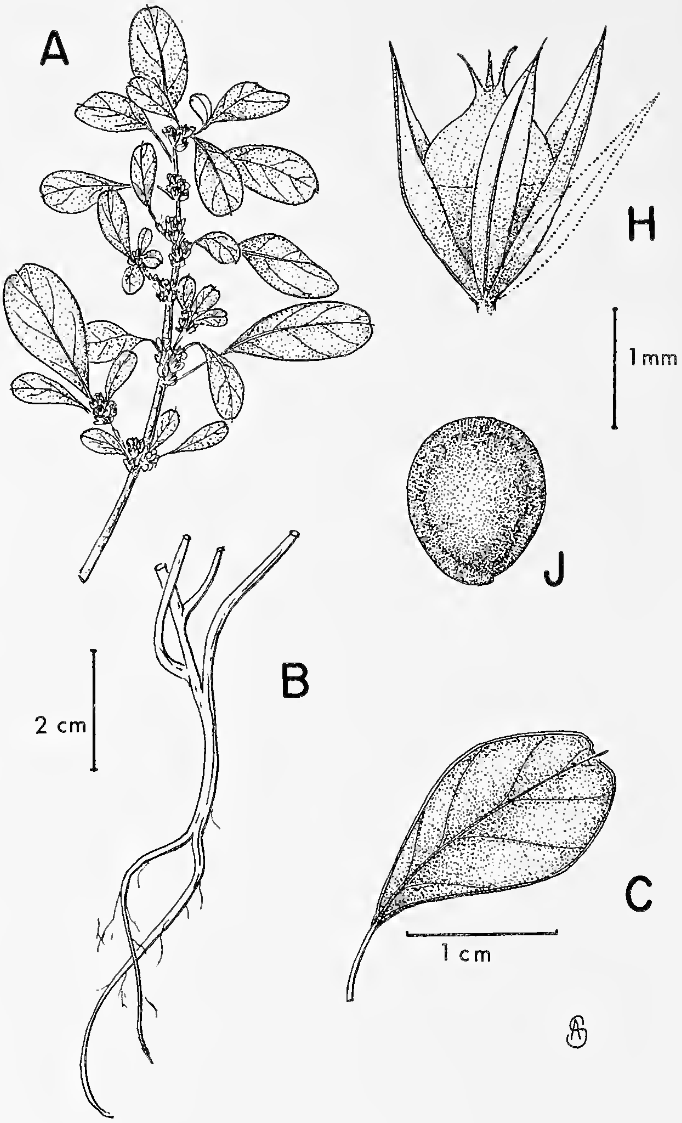
1.0 (-1.2) mm in diameter, 0.5-0.6 mm thick, testa smooth; **sepals** 3, oblong to linear, acute to acutish, 1-nerved, the nerve not excurrent, green along the nerve, often tinged with red, 0.8-1.2 mm long, 0.3-0.5 mm broad; **bract** oblong-lanceolate, 2.0-2.6 mm long, 0.3-0.6 mm broad, acuminate, midrib excurrent into a pungent point, spreading; **male flowers: stamens** 3; **filaments** membranaceous, 0.5-1.0 mm long; **anthers** ellipsoid, light yellow, 0.5-0.8 mm long; **sepals** 3, oblong, cuspidate, 1.2-2.3 mm long; **bract** lanceolate; **inflorescences** of axillary glomerules; **glomerules** bisexual, sessile, 2-3 mm in diameter; **leaves** elliptic to oblong, spatulate or obovate, 0.5-4.2 (-7) cm long, 0.4-2.3 cm broad, larger leaves usually early deciduous, obtuse to retuse at the apex, conspicuously mucronate, cuneate at the base, conspicuously veined, veins whitish beneath, glabrous; **petioles** slender, 0.5-3.5 (-5) cm long, glabrous; **stems** stout, erect, 3-12 dm tall, striate, whitish, glabrous or sparingly puberulent or villous, especially near the ends, densely branched, the branches ascending or divaricate; **root system** annual with a taproot (2n = 32).

Infraspecific Variation: In our range, plants are pyramidal, but in the western United States the plants often have a spherical to ovoid "tumbleweed" shape. Red-tinted plants have been separated as forma *rubricundus* (Thell.) Priszter.

Importance: This species is a common weed in many parts of the world, becoming a nuisance where windblown aggregations of the dead plants collect massively.

Nomenclatural Note: This species has long been known under the name *A. graecizans* L., but Thellung (Ascherson & Graebner, 1919) showed that *A. graecizans* is exclusively a European plant. *Amaranthus graecizans* can be distinguished from *A. albus* by its short bracts and from *A. blitoides* S. Wats. by its 3 sepals, which are shorter than the fruit. No true *A. graecizans* from North America has been seen.





6. *Amaranthus blitoides* S. Wats.

Common Names: Prostrate Pigweed, Tumbleweed

Type Description: S. Watson, Proc. Am. Acad., vol. 12, p. 273, 1877

Synonym: *Amaranthus graecizans* of American authors *pro parte*, not L.

Origin: A native of western North America

Habitats: Pastures, fields, roadsides, railroad tracks, dumps and other waste areas; in its native range also in dry prairies and stream valleys

Habit: Spreading, annual herbs

Flowering: July-early September

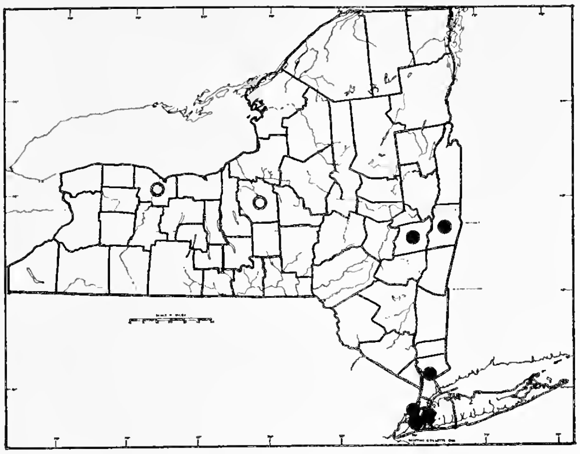
Fruiting: August-October

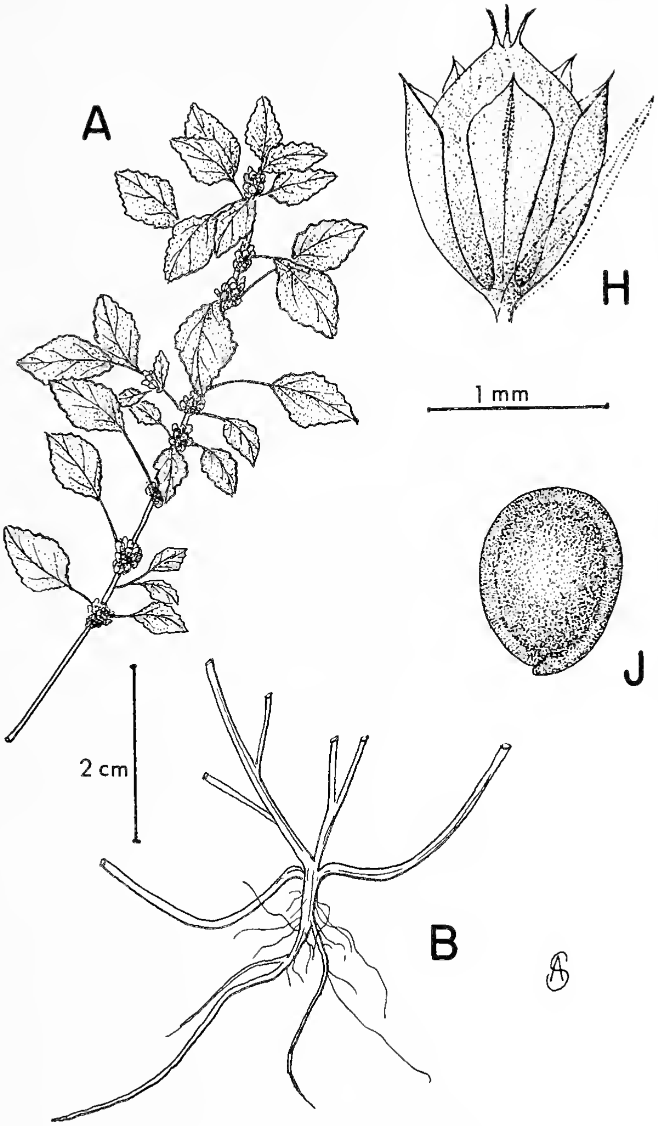
General Distribution: Manitoba to British Colombia south to California and Texas, adventive eastward to the Atlantic coast, Mexico, West Indies and Eurasia

Description: Plants **monoecious; female flowers: stigmas** 3, spreading, 0.5-0.7 mm long, swollen at base; **style** absent; **fruit** dry, circumscissile, obovoid to subglobose, 1.5-2.1 mm long, 1.4-1.8(-2) mm broad, usually smooth, stramineous, sometimes tinged with red; **seed** black, lenticular, round in outline, 1.3-1.6 (-1.8) mm in diameter, 0.9-1.0 mm thick, testa smooth; **sepals** 4-5, oblong to narrowly oblong, acuminate, 1-nerved, green along the nerve, 1.2-2.7 mm long, 0.5-0.7 mm broad; **bract** oblong to lanceolate, 1.0-2.5 mm long, 0.4-0.6 mm broad, acute to acuminate, midrib excurrent into a pungent point; **male flowers: stamens** 3; **filaments** membranaceous, 0.7-1.7 mm long; **anthers** ellipsoid, light yellow, 1.0-1.1 mm long; **sepals** 4-5, oblong, acute, 1.3-2.0 mm long, 0.4-0.6 mm broad; **bract** oblong to lanceolate, acute to acuminate, 1.5-2.2 mm long, 0.4-0.9 mm broad; **inflorescences** of axillary glomerules; **glomerules** bisexual, sessile, 3-5 mm in diameter; **leaves** obovate to oval, spatulate or elliptical, 0.8-2.3 (-4) cm long, 0.2-1.4 cm broad, apex rounded to acute, base cuneate to attenuate, conspicuously veined, veins whitish beneath, the smaller leaves with whitish margins, glabrous; **petioles** stout, 0.2-2.0 cm long, glabrous; **stems** stout, prostrate, 1.1-6.0 dm long, smooth to striate, whitish to pale green, rarely tinged with red, glabrous or sparingly puberulent, densely-branched; **root system** annual with a taproot (2n = 32).

Importance: This species has become a common weed in fields.

Note: See the nomenclatural discussion following *A. albus*.





7. *Amaranthus crispus* (Lesp. & Thév.) Terracc.

Common Name: Crisp-leaved Amaranth

Type Description: Lespinasse & Théveneau, Bull. Soc. Bot. France vol. 6, p. 656, 1859

Synonym: *Euxolus crispus* Lesp. & Thév.

Origin: A native of Argentina

Habitats: Sidewalks, ballast and waste ground about cities

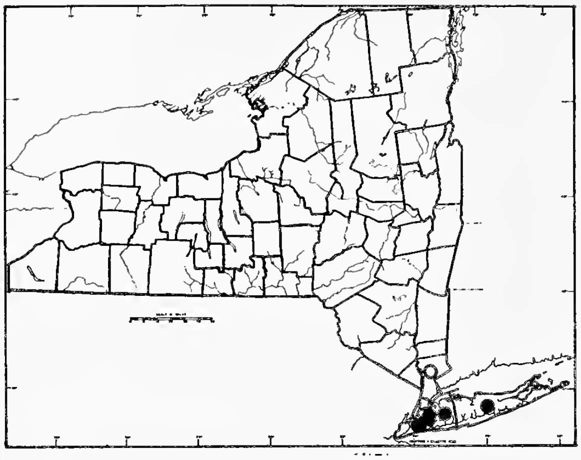
Habit: Spreading, mat forming, annual herbs

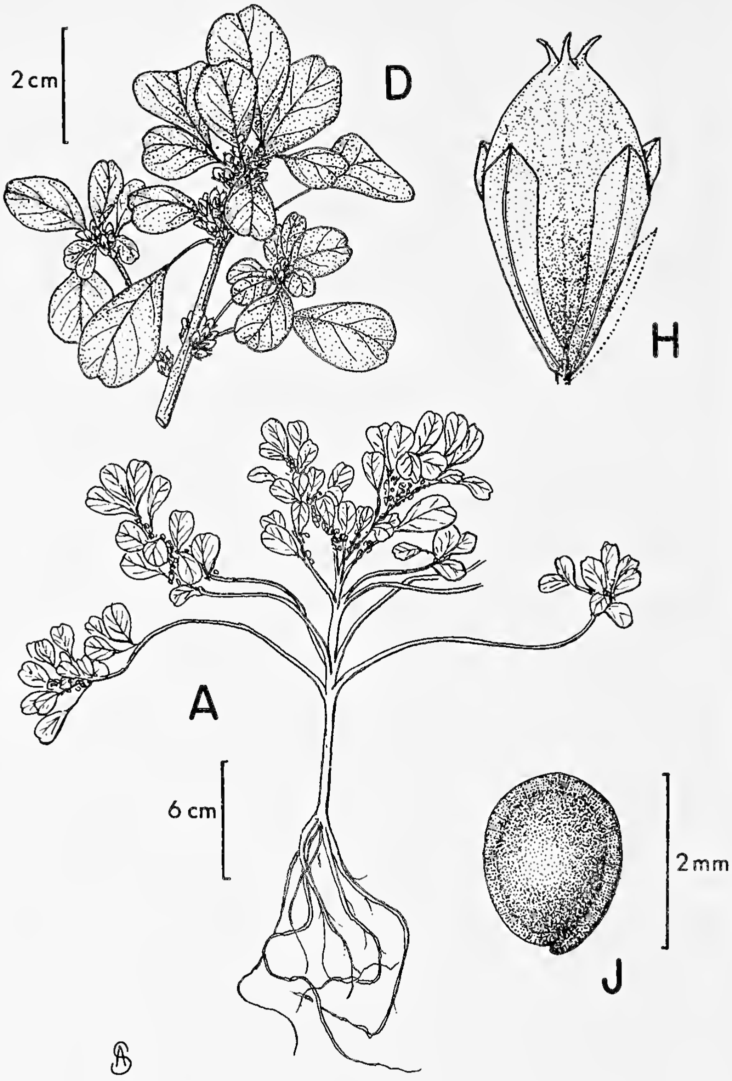
Flowering: July-August

Fruiting: August-October

General Distribution: A native of Argentina, naturalized in southern Europe and in parts of the United States (New York)

Description: Plants **monoecious**; **female flowers**: **stigmas** 3, spreading, 0.4-0.7 mm long; **style** absent; **fruit** indehiscent, ellipsoid, 1.5-2.0 mm long, 0.7-1.0 mm broad, rugose, stramineous; **seed** black to dark reddish-brown, lenticular, obovoid, 0.7-1.0 mm in diameter, 0.4-0.5 mm thick, testa smooth; **sepals** 5, oblong-spatulate, obtuse with 1 white, excurrent nerve, 1.2-1.7 mm long, 0.5-0.6 mm broad; **bract** lanceolate to oblong, 1.0-1.5 mm long, ca. 0.5 mm broad, acute, the midrib excurrent into a pungent point, spreading; **male flowers: stamens** 5; **filaments** membranaceous, 0.4-0.5 mm long; **anthers** ellipsoid, light yellow, 0.6-0.7 mm long; **sepals** 5, oblong, acute, 1.0-1.2 mm long, 0.4-0.8 mm broad; **bract** lanceolate, 1.0-1.1 mm long, 0.3-0.4 mm broad; **inflorescences** of axillary glomerules; **glomerules** bisexual, sessile, 2.5-4.0 mm in diameter; **leaves** rhombic-ovate to oblong, 0.5-1.1 (-2.5) cm long, 3-7 mm broad, apex acute, base cuneate, conspicuously crisped, puberulent beneath, prominently veined, sparsely pubescence; **petioles** stout, 0.2-0.7 cm long, sparsely pubescent; **stems** slender, prostrate, forming mats 2-8 dm in diameter, striate, stramineous, much-branched; **root system** annual with a taproot.





8. *Amaranthus pumilus Raf.*

Common Names: Seabeach Amaranth, Coast Amaranth

Type Description: Rafinesque, Med. Reps. II., vol. 5, p. 360, 1808

Synonym: *Euxolus pumilus* (Raf.) Chapm.

Origin: Native to the Mid-Atlantic Coast of North America

Habitats: Sandy sea beaches and inlets, storm washouts, sometimes within the tidal zone, but often inhabiting wrack or drift-lines at the high-water mark

Habit: Fleshy, prostrate to ascending, annual herbs

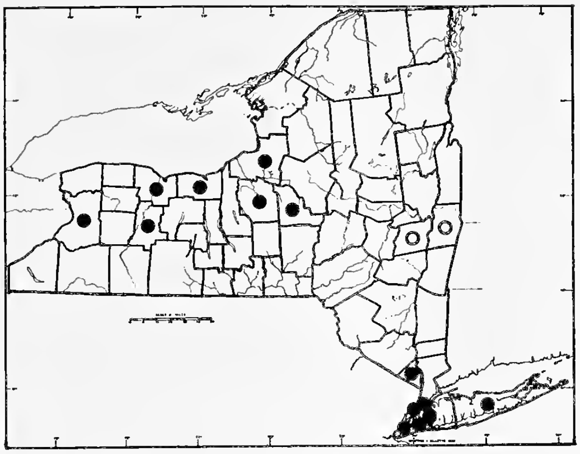
Flowering: July-August

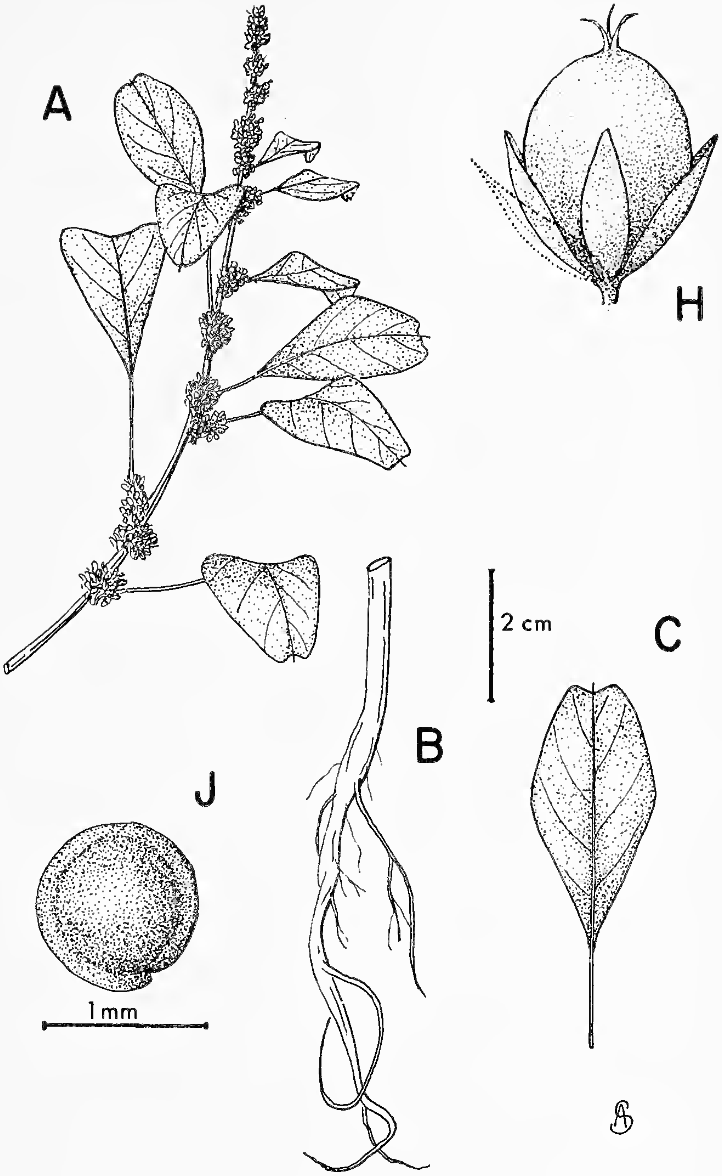
Fruiting: August-September

General Distribution: The Atlantic Coast, primarily on barrier islands, from Rhode Island and New York south to South Carolina; a "fugitive" species that does not necessarily occur throughout its potential range at any given time

Rarity Status: This species was thought to be extirpated in New York State until the summer of 1990, following a Carolina hurricane, when populations showed up on the beaches of three Long Island counties. The New York Natural Heritage Program ranks the species G2 S1, globally imperiled throughout its range, and critically imperiled in New York State. The Federal status of the species is C2, making it a candidate for listing pending further study.

Description: Plants **monoecious; female flowers: stigmas** 3, spreading, 0.6-0.7 mm long; **style** absent; **fruit** fleshy, indehiscent, ovoid to obovoid, 2.5-4.0 mm long, 2.0-2.6 mm broad, rugose, faintly 5-ribbed, stramineous; **seed** dark reddish-brown to black, lenticular, oval, 1.7-2.2 mm in diameter, 1.1-1.3 mm thick, testa smooth; **sepals** 5, narrowly oblong-spatulate, obtuse, 1-nerved, green along the nerve, 2.5-3.0 mm long, 0.9-1.1 mm broad; **bract** lanceolate, 0.9-1.2 mm long, 0.2-0.3 mm broad, acute, midrib not excurrent; **male flowers: stamens** 5; **filaments** membranaceous, 1.0-1.1 mm long; **anthers** ellipsoid, light yellow, 1.0-1.5 mm long; **sepals** 5, oblong, obtuse, 1.6-2.0 mm long, 0.9-1.1 mm broad; **bract** lanceolate, 0.9-1.2 mm long, 0.2-0.3 mm broad; **inflorescences** of axillary glomerules; **glomerules** bisexual, sessile, 5.5-11.0 mm in diameter; **leaves** clustered at the ends of the branches, obovate to suborbicular, 0.8-2.0 cm long, 0.7-1.4 cm broad, apex rounded or commonly emarginate, base rounded to attenuate, decurrent, glabrous, fleshy, prominently veined, the veins often red-purple; **petioles** stout, 0.2-1.1 cm long, glabrous; **stems** stout, succulent, prostrate or ascending, 0.4-3.0 dm tall, striate, greenish or red to stramineous, densely branched, the branches ascending or divaricate; **root system** annual with a taproot.





9. ***Amaranthus blitum*** **L.**

Common Names: Livid Amaranth, Purplish Amaranth

Type Description: Linnaeus, Species Pl. II, p. 990, 1753

Synonyms: *Amaranthus lividus* L., *A. ascendens* Loisel.

Origin: A native of tropical America

Habitats: Weedy in waste areas, gardens, dumps, shores, and along railroad tracks

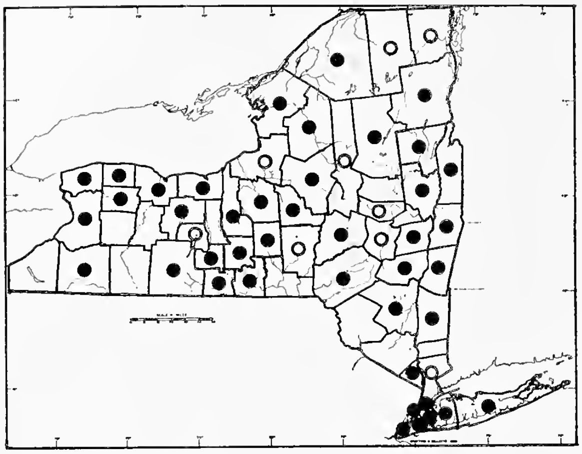
Habit: Spreading, succulent herbs

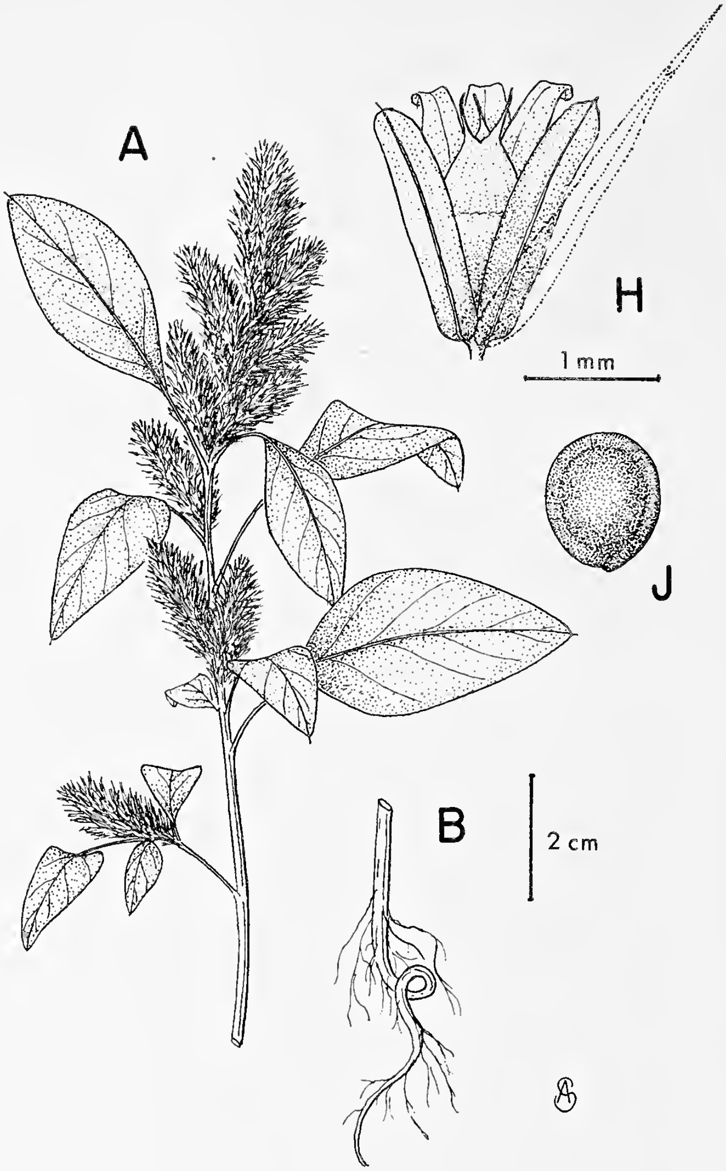
Flowering: June-August

Fruiting: August-October

General Distribution: Widespread in the tropics and warm-temperate areas; in North America, naturalized from Quebec and Ontario south to Maryland

Description: Plants **monoecious**; **female flowers: stigmas** 3, erect or spreading, 0.1-0.3 mm long; **style** absent; **fruit** dry, indehiscent, globose to ovoid, 1.2-2.0 mm long, 1.2-1.9 mm broad, smooth, green; **seed** dark reddish-brown to black, lenticular to rotund, 0.8-1.0 mm in diameter, 0.5-0.6 mm thick, testa smooth; **sepals** 3, oblong to oblanceolate, obtuse to acute, with a single midnerve, 0.7-1.4 mm long, 0.4-0.5 mm broad; **bract** oblanceolate, 0.7-1.3 mm long, ca. 0.3 mm broad, obtuse to acute, the midrib not excurrent; **male flowers: stamens** 3; **filaments** membranaceous, ca. 1 mm long; **anthers** ellipsoid, light yellow, 0.5-0.6 mm long; **sepals** 3, lanceolate, acuminate, 0.9-1.2 mm long, 0.3-0.5 mm broad; **bract** lanceolate, acuminate, 0.5-0.7 mm long, ca. 0.3 mm broad; **inflorescences** terminal and axillary, leafless spikes, 2-7 cm long, 5-8 mm broad (often with glomerules in the leaf axils); **glomerules** bisexual, sessile, 3-7 mm in diameter; **leaves** rhombic-ovate to broadly ovate, 1-8 cm long, 0.7-4.5 cm broad, glabrous, apex deeply emarginate, the lobes broad and rounded, base cuneate to rounded; **petioles** slender, 0.5-6.0 cm long, glabrous; **stems** slender to stout, succulent, erect to prostrate, forming mats 5-20 dm wide, striate, green, or with a reddish tinge, glabrous; **root system** annual with a taproot (2n = 34).





10. ***Amaranthus retroflexus*** **L.**

Common Names: Pigweed, Green Amaranth, Wild Beet, Redroot Amaranth, Redroot Pigweed

Type Description: Linnaeus, Species Pl. II, p. 991, 1753

Synonym: *Galliaria scabra* Bub.

Origin: A native of the northeastern United States

Habitats: Waste ground, cultivated ground, along railroad tracks, ballast, stream banks and stony beaches

Habit: Erect, annual herbs

Flowering: July-August

Fruiting: August-October

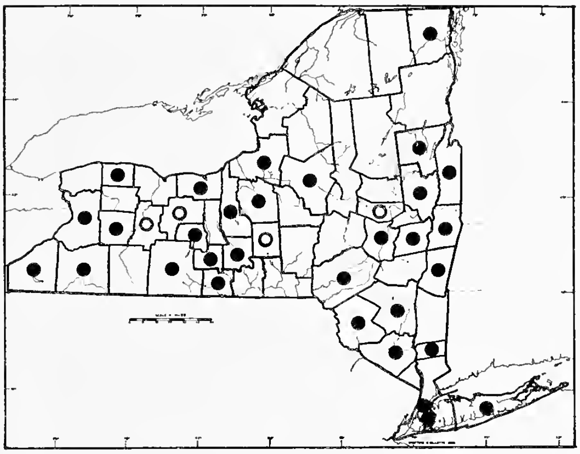
General Distribution: Nova Scotia to the Northwest Territories south to Mexico, now spread throughout temperate regions of the world

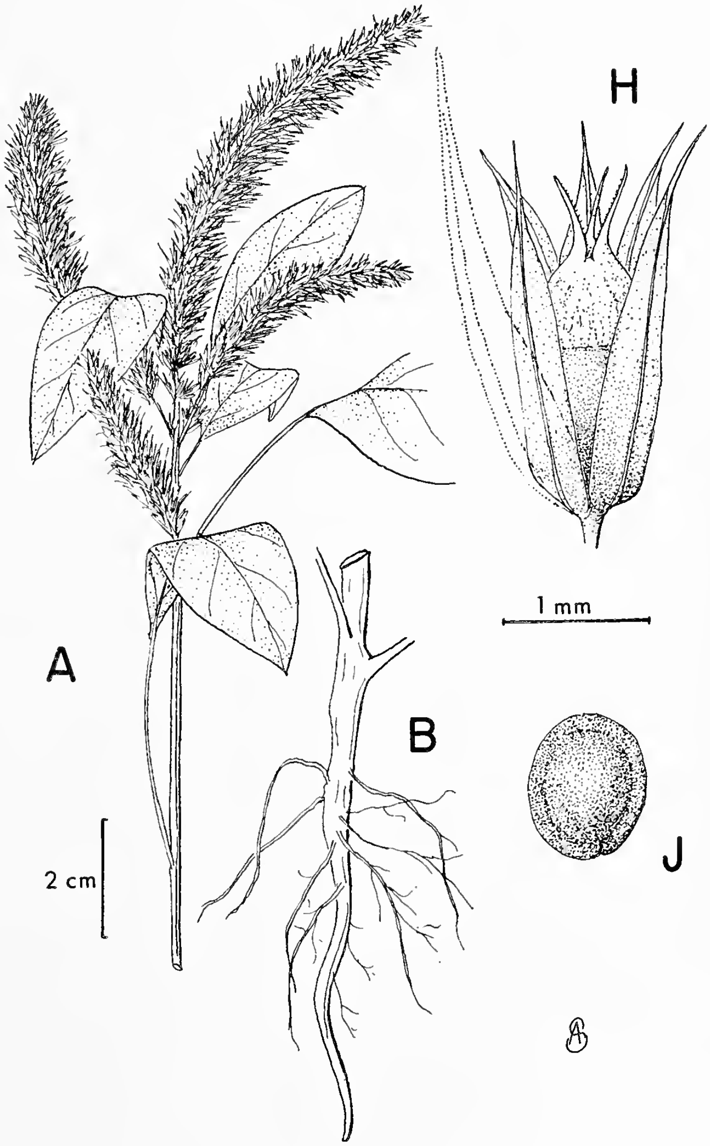
Description: Plants **monoecious**; **female flowers: stigmas** 3, erect, 0.7-0.9 mm long; **style** absent; **fruit** circumscissile, subglobose, 1.2-1.8 mm long, 1.0-1.3 mm broad, rugose above, stramineous; **seed** black and lustrous, lenticular, obovate or oval, 0.9-1.2 mm in diameter, 0.5-0.6 mm thick, testa smooth; **sepals** 5, linear-oblong, rounded or truncate, apex usually emarginate, often mucronate, whitish except for the green midnerve, 2.2-3.2 mm long, 0.7-1.0 mm broad; **bract** lanceolate to ovate, 3.7-7.0 mm long, 0.7-1.0 mm broad, tapering to a stout subulate tip; **male flowers: stamens** 5; **filaments** membranaceous, 0.9-1.5 mm long; **anthers** ellipsoid, light yellow, 0.9-1.0 mm long; **sepals** 5, ovate-oblong to lanceolate, 2.0-2.6 mm long, 0.6-0.9 mm broad, acute to acutish, the midnerve with an excurrent tip ca. 3 mm long; **bract** narrowly lanceolate, 3.7-7.0 mm long, 0.7-1.0 mm broad, acuminate; **inflorescences** terminal compound spikes and axillary spikes, 1.0-4.5 (-8) cm long, 0.7-1.5 cm broad, occasionally with glomerules in the axils of the upper leaves; **glomerules** bisexual, subsessile, tightly congested and not distinct; **leaves** lanceolate, lanceolate-ovate to obovate-oblanceolate, 2-12 cm long, 1.5-7.0 cm broad, apex acute to obtuse, often emarginate, base acute or obtuse, sometimes crisped, glabrous above, more or less villous to puberulent beneath, prominently veined, the veins white beneath; **petioles** slender, 1.5-8.0 cm long, usually villous; **stems** stout, erect or ascending, 3-30 dm tall, obtusely angled, green or whitish, abundantly villous at least above; **root system** annual with a taproot (2n = 34).

Infraspecific Variation and Hybridization: Several varieties and subvarieties have been named in Europe, including plants with red-tinted stems and inflorescences, called subvar. *rubricaulis* Thell. Those plants with longer bracteoles on the female flowers 1.3-1.5 times as long as the flowers (a common situation in NY) have been called *A. retroflexus* var. *delilei* (Richter & Loret)

Thell., the typical variety has longer bracteoles, twice as long as the female flowers. These proposed taxa merge completely, show no other distinctions, and are, therefore, not assigned taxonomic rank in this treatment. *Amaranthus retroflexus* hybridizes with several other species, most commonly *A. hybridus* and *A. powellii*. Introgression of *A. retroflexus* genes into *A. hybridus* is reported as one reason for well-known difficulties in determining the identity of *A. hybridus* plants. In New York State, one should have little difficulty distinguishing most individuals of these species from those of *A. retroflexus*, but there are specimens that show traits of both species.

Importance: Under certain soil and moisture conditions, *Amaranthus retroflexus* accumulates nitrates and may retain them in amounts that are poisonous to livestock. The stems and branches are the primary nitrate storage organs. In some areas, however, the species has been reported as palatable to sheep as oats and is said to have nutrient-composition and digestibility characteristics equivalent to those of high-quality alfalfa. The species is listed as a noxious weed in a number of states, and it may, also, be an alternate host for a number of detrimental crop diseases. It is known to reduce some crop yields significantly through competition.





11. ***Amaranthus powellii*** **S. Watson**

Common Names: Amaranth, Powell's Amaranth

Type Description: S. Watson, Proc. Amer. Acad. 10: 347, 1875

Origin: Native to the western United States

Habitats: Usually a weed of cultivated fields, but also found on waste ground, roadsides, along railroad tracks and in dumps

Habit: Erect, annual herbs

Flowering: July-August

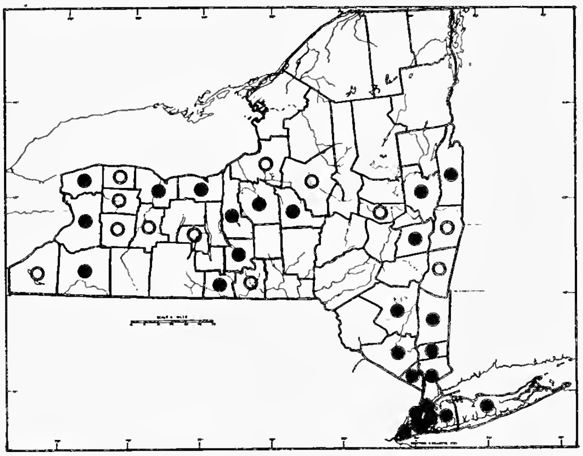
Fruiting: August-October

General Distribution: Prince Edward Island to British Columbia south to Mexico, Texas and Pennsylvania

Description: Plants **monoecious**; **female flowers: stigmas** 3, spreading, 0.5-0.7 mm long; **style** absent; **fruit** circumscissile, oval, 1.8-2.2 mm long, 1.1-1.4 mm broad, rugose above, stramineous; **seed** reddish-brown

to usually black, lenticular, round in outline, 1.0-1.3 mm in diameter, 0.5-0.6 mm thick, testa smooth; **sepals** 3-5, oblong or linear-oblong, acute, 1-nerved, the nerve usually excurrent as a spinose tip, 1.5-3.0 mm long, 0.5-0.6 mm broad; **bract** linear-lanceolate, longer bracts 4.0-7.5 mm long, 0.9-1.2 mm broad, attenuate with a rigid spinose tip; **male flowers: stamens** 3 (-5); **filaments** membranaceous, ca. 1 mm long; **anthers** ellipsoid, light yellow, 0.5-0.6 mm long; **sepals** 5, narrowly oblong to ovate, 2-3 mm long, 0.5-0.6 mm broad, 1-nerved, the nerve usually excurrent; **bract** linear-lançeolate, 4-7 mm long, 0.9-1.1 mm broad; **inflorescence** a terminal spike or compound spike, 1.0-4.5 cm long, 1.0-1.8 cm broad; **glomerules** bisexual, subsessile, closely congested and not measurable; **leaves** rhombic-ovate to lanceolate, or deltoid-elliptic, 1.5-10.0 (-12) cm long, 0.5-4.0 cm broad, apex acute to rounded, sometimes emarginate, base cuneate to rounded, glabrous or sparsely pubescent; **petioles** slender, 1-5 cm long, glabrous or sparsely pubescent; **stems** stout, erect, 3-20 dm tall, striate, green or whitish, glabrous below, usually villous above; **root system** annual with a taproot (2n = 34).

Interspecific Variation and Hybridization: This species is reported to hybridize with *A. retroflexus*, *A. tuberculatus*, and *A. hybridus*. Sauer and Davidson (1961) reported sterile hybrids between *A. retroflexus* and *A. powellii* only occurring since 1922. Hybrids involving *A. powellii* should be expected in New York, particularly since *A. powellii* is becoming more widespread.



12. *Amaranthus hybridus* L.

Common Names: Green Amaranth, Pigweed, Wild Beet, Prince's-feather, Spleen Amaranth

Type Description: Linnaeus, Species Pl. II, p.990, 1753

Synonyms: *Amaranthus chlorostachys* Willd., *A. incuvatus* Ti. ex Gren. & Godr., *A. patulus* Berol.

Origin: A native of the New World, probably the tropics

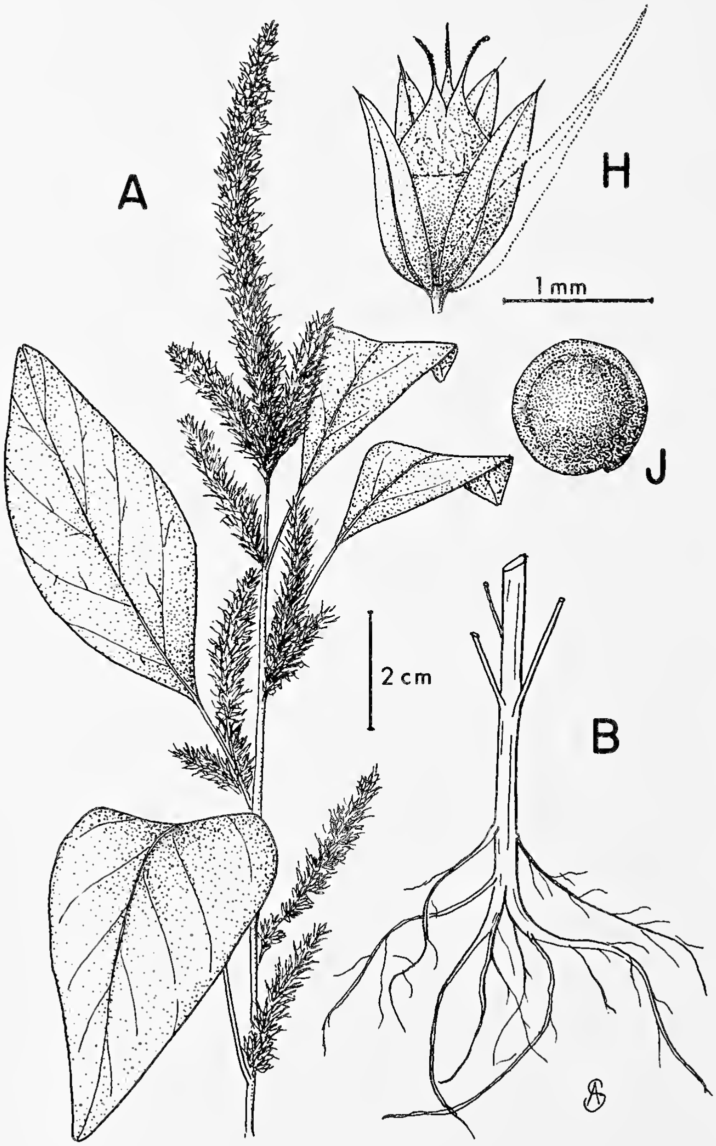
Habitats: Waste areas, fields, along railroad tracks, river flats, roadsides, ballast, dumps, weedy areas and cultivated soils

Habit: Erect, annual herbs

Flowering: June-August

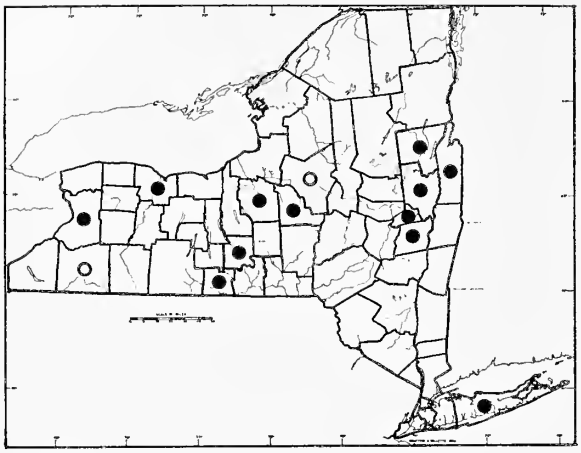
Fruiting: August-November

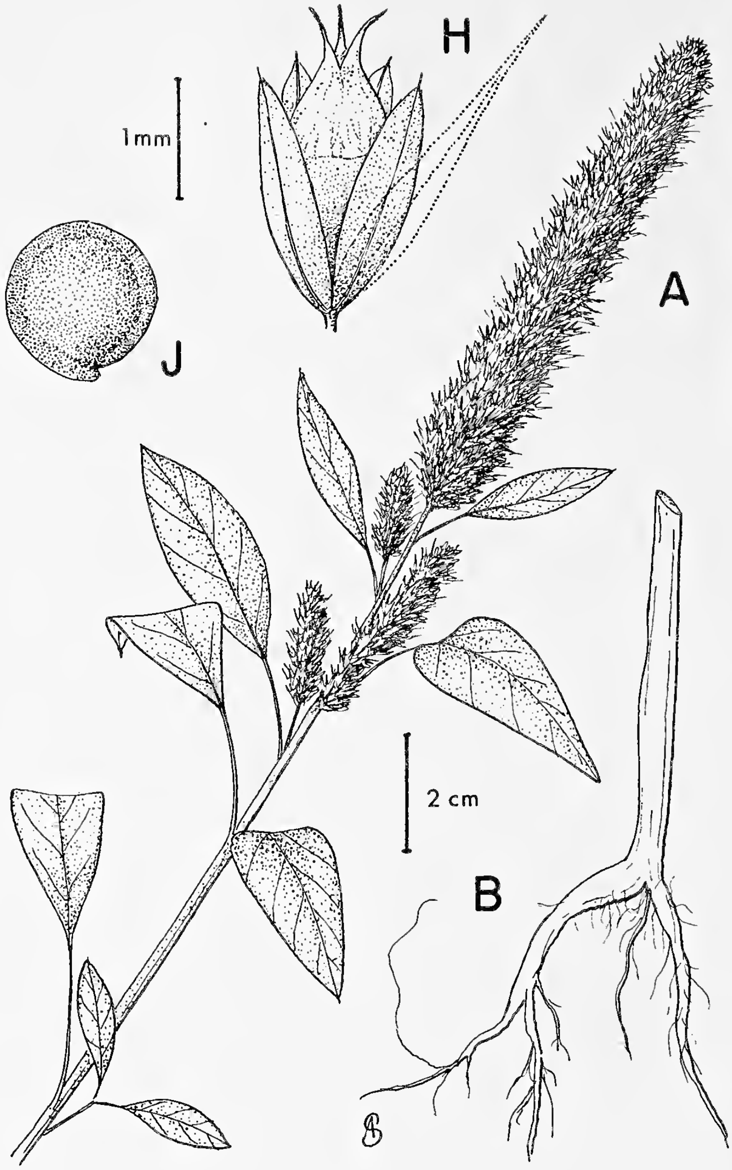
General Distribution: Quebec to Manitoba south to Mexico, Central and South America



Description: Plants **monoecious; female flowers: stigmas** 3, erect or spreading, 0.3-0.5 mm long; **style** absent; **fruit** obovoid, circumscissile, 1.2-2.1 mm long, 0.9-1.3 mm broad, usually smooth, stramineous; **seed** black or dark reddish-brown, lenticular, round in outline, 0.8-1.1 (-1.5) mm in diameter, 0.5-0.6 mm thick, testa smooth; **sepals** 5, oblong to ovate or lanceolate, acute, scarious, 1-nerved, the nerve usually excurrent, 1.2-2.1 mm long, 0.4-0.5 mm broad; **bracts** lanceolate to ovate, 2.2-3.4 (-4.2) mm long, 0.6-0.7 mm broad, tapering to short spinose tip; **male flowers: stamens** 5; **filaments** membranaceous, 0.6-1.0 mm long; **anthers** ellipsoid, light yellow, 0.6-0.7 mm long; **sepals** usually 5, narrowly oblong to ovate, acute, 1-nerved, the nerve usually excurrent, 1.7-2.0 mm long, 0.2-0.3 mm broad; **bract** lanceolate to ovate, 2.0-2.7 mm long, 0.4-0.6 mm broad; **inflorescences** terminal compound spikes and axillary spikes, 10-25 cm long, ca. 1 cm broad; **glomerules** bisexual, subsessile, tightly congested and not distinct; **leaves** lanceolate to ovate or rhombic-ovate, 3-15 cm long, 1-7 cm broad, apex acute or rarely rounded, base cuneate or rounded, pubescent beneath or glabrous, prominently veined; **petioles** slender, 1.5-9.0 cm long, pubescent; **stems** stout, erect or ascending, 3-15 (-25) dm tall, striate, pale green, usually tinged with red, rough puberulent below or glabrous, villous above; **root system** annual with a stout taproot (2n = 32).

Interspecific Variation and Hybridization: Much of the taxonomic difficulty with the *A. retroflexus*, *A. powellii*, *A. hybridus* complex may be attributed to hybridization. Murray (1940) found little fertility in F1 hybrids, and F2 generation plants are rarely produced; however, hybrids are reported to be common where these species co-occur in nature. In fact, Sauer (1950) suggested that much of the variation reported in *A. hybridus* is the result of introgression from *A. retroflexus*. Intermediate specimens are readily apparent in New York collections. In general, specimens that exhibit mostly *A. hybridus* characters have been treated as *A. hybridus*, a situation complicated by the fact that this species is also reported to hybridize with other members of the genus.





13. ***Amaranthus hypochondriacus*** **L.**

Common Name: Prince's-feather

Type Description: Linnaeus, Species Pl. II, p. 991, 1753

Origin: Probably originally native to Mexico, derived from *A. hybridus* or *A. powellii* through selection by man

Habitats: Waste places and cultivated ground

Habit: An erect, annual herb

Flowering: July-August

Fruiting: August-October

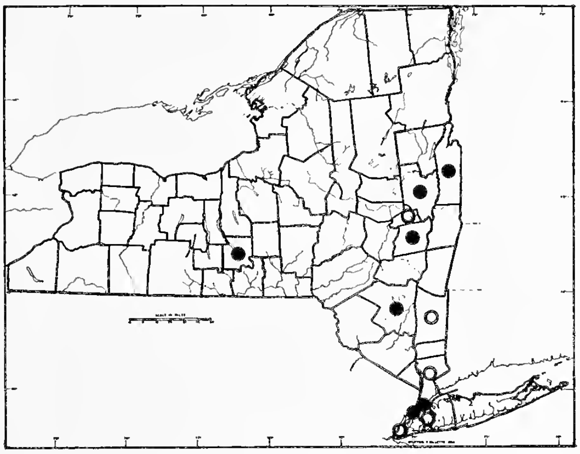
General Distribution: Arizona to Guatemala, now escaping in scattered localities from New York to Wisconsin and Missouri

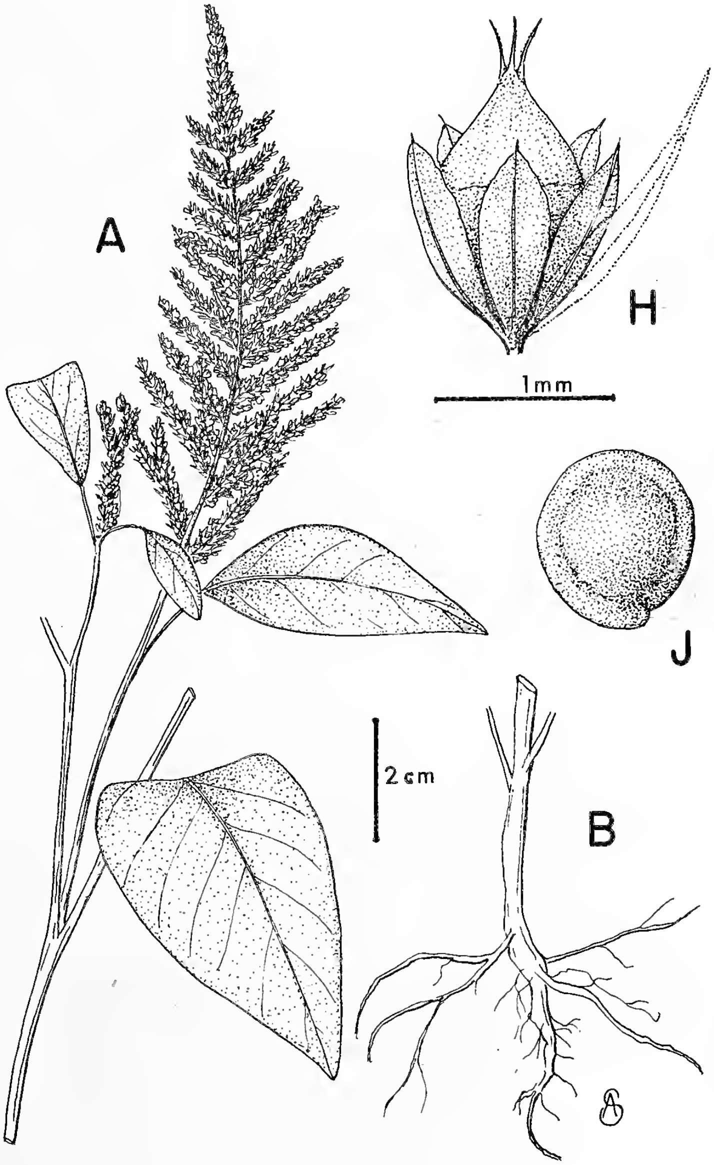
Description: Plants **monoecious**; **female flowers: stigmas** 3, erect or spreading, 0.4-0.6 mm long, thick at base; **style** absent; **fruit** circumscissile, subglobose, 2.0-2.4 mm long, 1.1-1.4 mm broad, often rugose, stramineous to deep red; **seed** black or dark reddish-brown or creamy in cultivated forms, lenticular, round in outline, 1.0-1.3 mm in diameter, 0.8-0.9 mm thick, testa smooth; **sepals** commonly 5, oblong to ovate, acute, 1-nerved, the nerve usually excurrent, 1.7-2.3 mm long, 0.5-0.8 mm broad; **bract** lanceolate to ovate, 2.8-3.4 mm long, 0.8-1.0 mm broad, tapering to short spinose tip; **male flowers: stamens** 5; **filaments** membranaceous, 1.0-1.4 mm long; **anthers** ellipsoid, light yellow, 0.7-0.9 mm long; **sepals** usually 5, narrowly oblong to ovate, 3.0-3.3 mm long, 0.5-0.6 mm broad, acute, 1-nerved, the nerve usually excurrent; **bract** lanceolate to ovate, 2.6-3.0 mm long, 1.0-1.2 mm broad; **inflorescences** terminal, compound spikes, spikes 6-17 cm long, 0.9-1.4 cm broad; **glomerules** bisexual, subsessile, closely congested and not measurable; **leaves** lanceolate to ovate or rhombic-ovate, 3-15 cm long, 1-7 cm broad, apex acute or rarely rounded, base cuneate, pubescent beneath or glabrous, prominently veined; **petioles** slender, 1.5-9.0 cm long, pubescent; **stems** stout, erect or ascending, 3-25 dm tall, striate, pale green, usually tinged with red, rough-puberulent or glabrous below, villous above; **root system** annual with a taproot (2n = 32).

Importance: This species is an important grain amaranth, and is the most prevalent species grown in the United States for Amaranth grain. It is grown more extensively in many parts of the tropics, particularly Mexico and India, where the fruits are toasted, popped like corn, or ground into flour — often mixed with syrup or honey to make candies. Among the Aztecs, this species was a very important ritual plant. Idols were made from a paste composed of ground, toasted amaranth seeds and, according to one report, the blood of human sacrifices. During major religious festivals, such idols were broken into pieces and eaten by the faith-

ful. The Spaniards considered this practice a perverse parody of the Catholic Eucharist and forbade it. Cortez even went so far as to burn all grain amaranth fields.

Interspecific Variation and Hybridization: This species is very similar to *Amaranthus hybridus*, and it is believed to be derived from that species or possibly *A. powellii* through selection as a grain crop. In general, the larger inflorescences, shorter bracts, and thick-based stigmas separate this species from *A. hybridus*, but the plants are often difficult to separate from it in New York, because *A. hypochondriacus* appears to be reverting to its "wild" form after it escapes.





14. *Amaranthus cruentus* L.

Common Names: Blood Amaranth, Purple Amaranth

Type Description: Linnaeus, Syst. Nat. ed. 10, p. 1269, 1759

Origin: Southern Mexico and Guatemala, probably through selective cultivation of *A. hybridus*

Habitats: Waste ground, dumps, cultivated fields and borders

Habit: Erect, annual herbs

Flowering: July-August

Fruiting: August-October

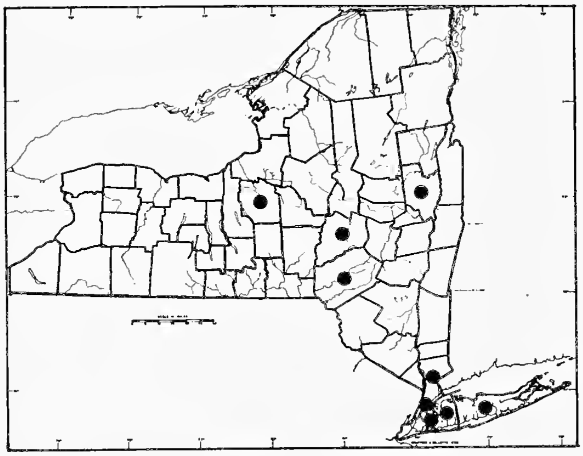
General Distribution: Scattered throughout much of the world particularly in the tropics. In North America, from Quebec to Alberta south to Mexico and Maryland

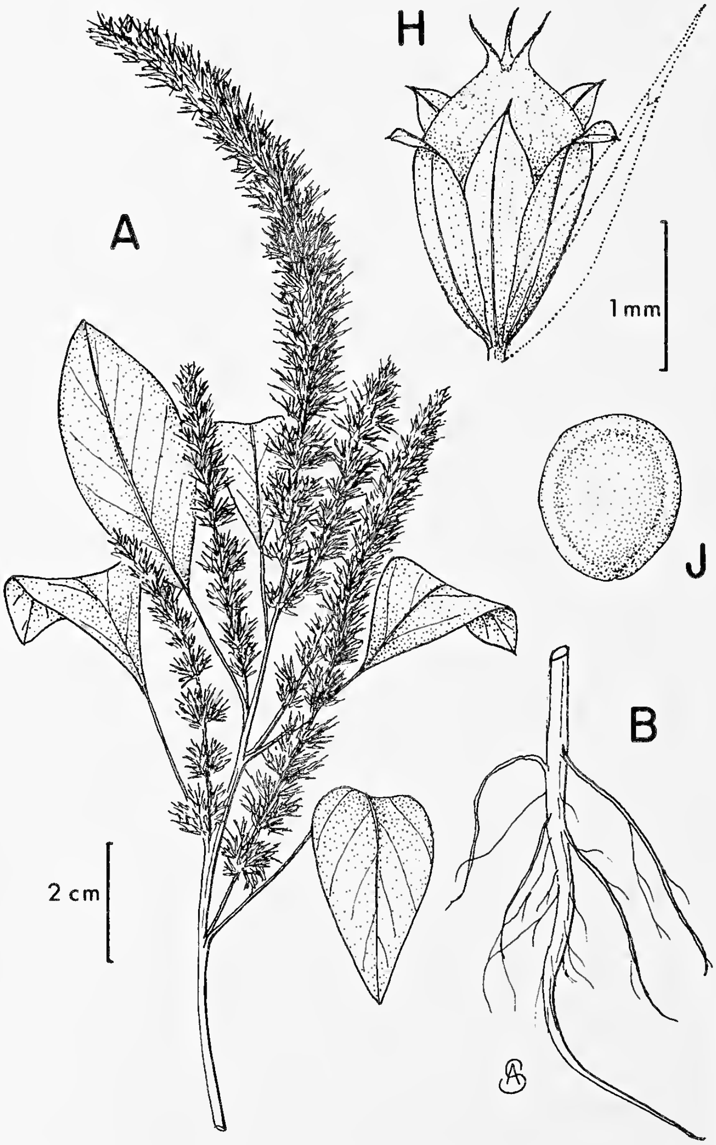
Description: Plants **monoecious; female flowers: stigmas** 3, erect, 0.4-0.5 mm long, slender at base; **style**

absent; **fruit** ovoid to broadly ovoid, circumscissile, 1.4-1.6 mm long, 1.1-1.4 mm broad, smooth to somewhat rugose on the upper half, stramineous or usually red; **seed** black or dark reddish-brown, lenticular, round in outline, 1.0-1.3 mm in diameter, 0.5-0.6 mm thick, testa smooth; **sepals** 5, oblong to narrowly oblong, obtuse to rounded, sometimes erose, the outer ones acute with an excurrent vein, red, reddish-orange or purple or sometimes green or stramineous, the inner ones faintly 1-nerved, not carinate, 1.0-1.7 mm long, 0.3-0.5 mm broad; **bract** lanceolate to ovate, 1.5-2.0 mm long, 0.5-0.9 mm broad, tapering to a short pungent tip; **male flower: stamens** 5; **filaments** membranaceous, 0.9-1.0 mm long; **anthers** ellipsoid, light yellow, 0.5-0.8 mm long; **perianth** of 5 sepals; **sepals** oblong-ovate, 1.0-1.7 mm long, 0.6-0.7 mm broad, acute, 1-nerved, the nerve excurrent; **bract** lanceolate to ovate, 1.2-1.4 mm long, 0.5-0.6 mm broad; **inflorescences** terminal compound spikes, 4-5 (-15) cm long, 4-5 (-12) mm broad, and lateral spikes 1.5-5.0 cm long, 0.3-0.6 mm broad; **glomerules** bisexual, subsessile, closely congested; **leaves** elliptic to ovate-lanceolate or rhombic-ovate, 3-30 cm long, 1.5-10.0 cm broad, apex attenuate or acute, the tip usually obtuse, base acute to attenuate, sparsely pubescent or glabrate; **petioles** slender, 2-20 cm long, often pubescent; **stems** stout, erect, 5-20 dm tall, striate, green or red, usually pubescent, villous near the inflorescence; **root system** annual with a taproot (2n = 32, 34).

Infraspecific Variation: A fairly homogenous species in our area, but intermediates are likely occur where the species grows sympatrically with *A. hybridus*.

Importance: One of the grain amaranths, also cultivated in many parts of the world as a pot herb. It is grown in Latin America and India for the seed, which is used as a grain in baking. The flour produced is high in protein content. It is also grown as an ornamental, a dye plant and a pot herb.





15. *Amaranthus caudatus* L.

Common Names: Purple Amaranth, Love-lies-bleeding

Type Description: Linnaeus, Species Pl. II, p. 990, 1753

Origin: The Andes, probably derived from *A. hybridus* through prolonged cultivation and selection

Habitats: Roadsides, gardens, waste places and cultivated ground

Habit: Erect, annual herbs

Flowering: June-August

Fruiting: August-September

General Distribution: South America; naturalized in North America from Quebec to Missouri south to Mexico

Description: Plants **monoecious**; **female flowers: stigmas** 3, spreading, 0.4-0.5 mm long, slender at base; **style** absent; **fruit** circumscissile, subglobose, 1.6-2.5 mm long, 0.9-1.2 mm broad, somewhat rugose on the upper half, stramineous or usually red; **seed** usually yellowish-white and dull, sometimes red to nearly black and lustrous, lenticular, round in outline, 0.9-1.2 mm in diameter, 0.5-0.6 mm thick, testa smooth; **sepals** 5, oblong, lance-oblong or spatulate, acute to attenuate, 1-nerved, usually red or purplish, but sometimes green, 1.4-2.0 mm long, 0.8-1.0 mm broad; **bract** lanceolate to ovate, 1.7-2.3 (-3.1) mm long, 0.9-1.1 mm broad, attenuate to a spinose subulate apex; **male flowers: stamens** 5; **filaments** membranaceous, 1.3-1.9 mm long; **anthers** ellipsoid, light yellow, ca. 0.8 mm long; **sepals** 5, oblong to ovate, 1.7-2.5 mm long, 0.5-0.9 mm broad, carinate, the midnerve excurrent as a pungent tip, usually tinged with red; **bract** lanceolate to ovate, 1.7-2.0 mm long, 0.7-0.8 mm broad; **inflorescences** terminal simple or compound spikes, terminal spikes usually pendant, (8-) 25-30 cm long, 0.8-1.0 cm broad, lateral spikes often lacking, or 2-7 cm long, 5-6 mm broad; **glomerules** bisexual, subsessile, closely congested; **leaves** alternate, lanceolate to ovate or rhombic-ovate, 3.5-10.0 (-20) cm long, 1.6-5.5 cm broad, apex acute or abruptly acute, base acute, conspicuously veined; **petioles** slender, 2-4 (-18) cm long, glabrous to sparsely tomentose; **stems** stout, erect, 3-10 (-20) dm tall [even larger in cultivation], striate, green or whitish often tinged with red, glabrous or sparsely villous around the inflorescence; **root system** annual with a taproot (2n = 32, 34).

Importance: This species is one of the grain amaranths that are important sources of food in some tropical countries. It is often grown as an ornamental or dye plant as well.

Variation: This species is probably derived through artificial selection from *A. hybridus*. Escaping populations are expected to cross with *A. hybridus* or revert to a wild state that does not exhibit the long "tail-like" inflorescence.

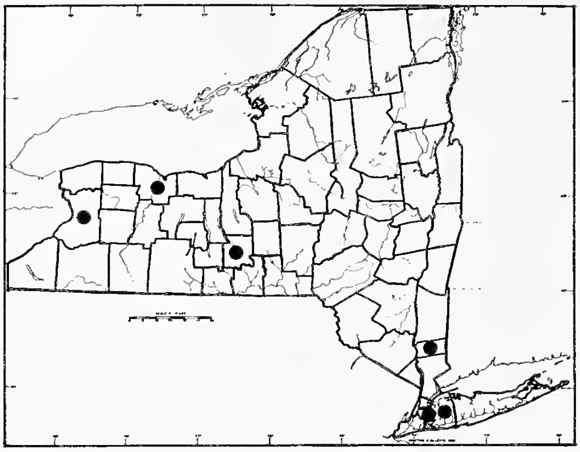
Waifs: *Amaranthus deflexus* L., with old reports from Albany, Schenectady, Richmond and Queens Counties; *Amaranthus palmeri* S. Wats., has been collected in Albany, Tompkins and Queens Counties.; *Amaranthus viridis* L. (*A. gracilis* Desf.), an old report from Rochester (Monroe Co.), Suffolk Co. and, recently, collected in Bronx County.

2. FROELICHIA

Common Name: Snake-cotton

Authority: Moench, Methodus, p. 50, 1794.

A genus of about 12 species, native to the Western Hemisphere from the middle latitudes of the United States south to Argentina and west to the Galapagos. Most species are found in the southwestern United States or Brazil. Two are known to occur in the eastern United States, but only one is reported from New York State. *Froelichia floridana* (Nutt.) Moq. var. *floridana* is found along the Coastal Plain as far north as New Jersey. It differs from *F. gracile* (Hook.) Moq. in having larger calyces (more than 5 mm long) with deeply and irregularly dentate crests and a profusely branching habit.



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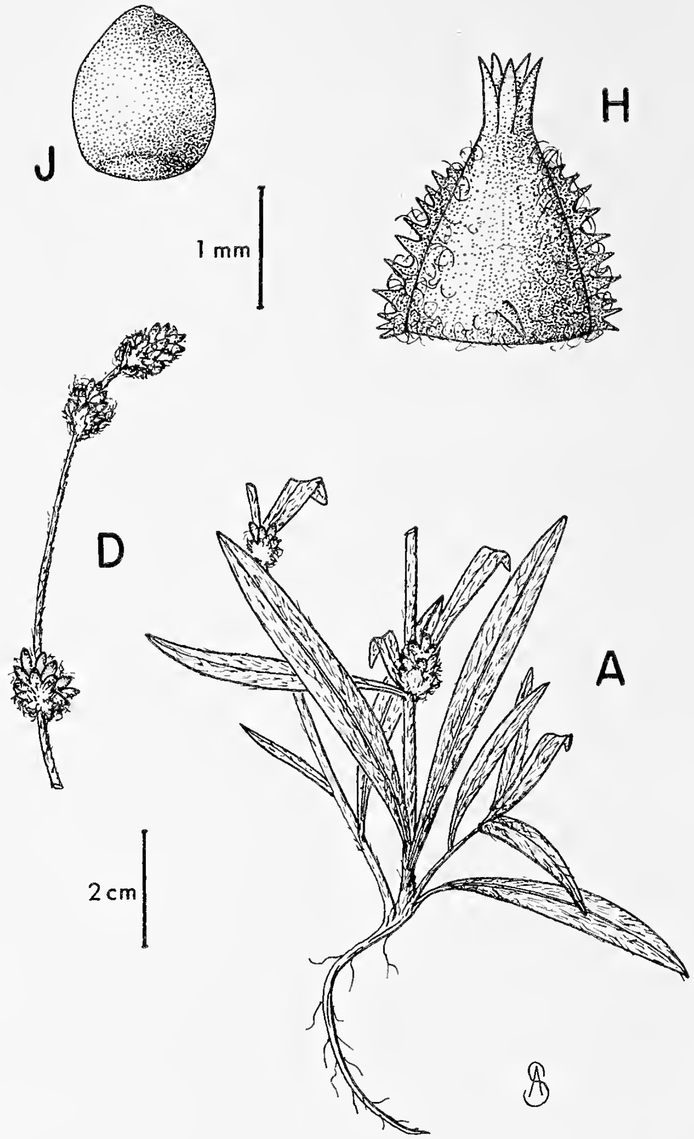

1. *Froelichia gracilis* (Hook.) Moq.

Common Names: Cotton-weed, Slender Snake-cotton

Type Description: W. J. Hooker, Icon. Pl., vol. 3, pl. 256, 1840

Synonym: *Oplotheca gracilis* Hook.

Origin: A native of the southwestern United States

Habitats: Sandy areas including sand dunes, prairies, pastures, stream valleys, sometimes in open woodlands; in eastern North America this species is often found on old cinders along railroads beds.

Habit: Erect or procumbent, taprooted annuals

Flowering: July-August

Fruiting: August-October

General Distribution: Probably native only west of the Mississippi River from Iowa to Colorado south to Texas and Chihuahua, Mexico; introduced in the east along railroads and highways, and now fairly widespread from New York to Ontario and Minnesota south to Florida

Description: Plants with **bisexual** flowers; **stigma** capitate, irregularly lobed, ca. 0.2 mm in diameter; **style** 1, 0.6-1.0 mm long; **ovary** 1, superior, unilocular, ovoid; **ovule** solitary, pendulous from the tip of the funiculus, the micropyle superior; **fruit** a membranaceous, indehiscent utricle, enclosed by the indurate calyx, 2.0-2.5 mm long, ca. 1.5 mm in diameter; **seed** 1, yellowish or reddish-brown, ovoid to pyriform, 1.2-1.7 mm long, ca. 1.2 mm in broad, testa smooth and usually lustrous; **embryo** annular, surrounded by a central, mealy **perisperm**, the **radicle** superior, usually germinating while enclosed within the calyx; **stamens** 5; **filaments** connate, the tube 1.8-3.0 mm long; **anthers** sessile on the staminal tube, alternating with 5 acute to obtuse lobes of the tube, ellipsoid, light yellow, 0.4-0.5 mm long; **perianth** a 5-lobed **calyx tube** that is conic to flask-shaped, 2.2-3.6 (-5) mm long, 1.7-2.2 mm broad (excluding spines), densely wooly with 2 lateral rows of distinct spines that are 0.4-0.9 mm long, the faces with 1-3 blunt or spine-like tubercles near the base; **calyx lobes** oblong linear, obtuse to acute, 0.7-1.4 mm long, 0.3-0.4 mm broad; **pedicels** very short, the flowers subsessile in spikes; **bracteoles** 2, detaching with the fruit, rotund, acute to emarginate (sometimes acuminate), scarious, 1.2-2.0 mm long, 1.5-1.8 mm broad, shorter than the calyx, white, yellowish, brownish, or blackish, glabrous; **peduncle** erect, 2.2-3.0 mm long, or absent from lateral spikes; **bract** at the base of the peduncle persistent, ovate, stramineous to brown, scarious, (0.5-) 1.2-2.0 mm long, 0.7-0.9 mm broad, glabrate, apex acuminate; **inflorescence** a raceme of spikes 0.7-3.2 cm long, (5-) 7-8 (-10) mm broad, lateral spikes sessile; **leaves** opposite, entire, often clustered near the base, linear, linear-lanceolate, narrowly oblanceolate to elliptic-lanceolate, 2.2-7.0 (-12) cm long, 2-7 (-12) mm wide, acute to acuminate

at the apex, cuneate at the base, sericeous or tomentose to silky on both surfaces; **petioles** absent; **stems** slender, (1-) 2-5 (-7) dm tall, simple or usually much-branched at the base, the branches ascending or somewhat proeumbent, densely or sparsely villous-tomentose and sometimes viscid above; **root system** annual with a single taproot.

3. GOMPHRENA

Common Name: Globe Amaranth

Authority: Linnaeus, Species Pl. I, p. 224, 1753

A genus of an estimated 100 species, mostly of the tropics, subtropics and warm-temperate regions of the New World, except for approximately 18 species native to Australia. The globe-amaranth (*Gomphrena globosa* L.) is commonly cultivated and occasionally escapes, but it does not persist in New York.

Waifs: *Gomphrena globosa* L. has been reported around New York City and from Orient Point, Suffolk Co.; *G. martiana* Gill. ex Moq. in DC., was collected earlier in the century near Yonkers wool mills, Westchester County.

4. ALTERNANTHERA

Common Name: Alligator-weed

Authority: Forsskål, Fl. Aegypt. Arab., p. 28, 1775

A genus of approximately 80 species (some estimates as high as 200). Most species occur in the American tropics and subtropics. Several species are aggressive weeds that have become naturalized in many parts of the world. None are persistent in New York.

Waif: *Alternanthera pungens* Kunz has been collected once in the past century from a wool-waste area in Yonkers (Westchester Co.), but it has not been seen since.

APPENDIX I

SOME FUNGI ASSOCIATED WITH PLANT SPECIES IN THIS TREATMENT

The following fungi associated with species in this treatment are listed to append the comprehensive treatment of fungal hosts published by Farr *et al.*, 1989. The reader is referred to that book for a more exhausted list of fungi. This list only includes species represented by specimens at the New York State Museum with host information.

PERONOSPORALES

Albugo bliti (Biv.-Bern.) Kuntze, on *Amaranthus retroflexus*, *A. viridis*, *A. cannabinus*

UREDINALES

Puccinia subnitens Diet., on *Atriplex hastata* [*A. prostrata*]
Uromyces shearianus Arthur, on *Atriplex hastata* [*A. prostrata*]

HYPHOMYCETES

Cercospora dubia (Pers.) Wint., on *Chenopodium album*
Cladosporium herbarum (Pers.) Link ex Fr., on *Chenopodium album*, *Amaranthus* sp.

APPENDIX II

A list of some insects associated with plant species in this treatment.

COLLEMBOLA

Bourletiella hortensis Fitch (Seedling Springtail), feeds on seedlings of *Chenopodium album* (Bassett & Crompton, 1978b)

THYSANOPTERA

Aeolothrips fasciatus L., on *Chenopodium album* (Bassett & Crompton, 1978b)
Haplothrips faurei Hd., on *Chenopodium album* (Leonard, 1928)
Taeniothrips vulgatissimus (Hal.), on *Chenopodium album* (Bassett & Crompton, 1978b)
Thrips fuscipennis (Hal.), on *Chenopodium album* (Bassett & Crompton, 1978b)
Thrips tabaci Lindemann, on *Chenopodium album* (Bassett &Crompton, 1978)

ORTHOPTERA

Orchelimum vulgare Harris (Common Meadow Katydid), laying eggs in *Chenopodium* (Leonard, 1928)

HEMIPTERA

Miridae
Atomoscelis modestus (Van Duzee), on *Chenopodium album* (Bassett & Crompton, 1978b)
Chlamydatus associatus (Uhler), on *Beta vulgaris* (Knight, 1941)
Lygus lineolaris (P. de B.), Tarnished Plant Bug, on *Chenopodium album* (Bassett & Crompton, 1978b), collected on *Amaranthus retroflexus* (Weaver & McWilliams, 1980)
Melanotrichus coagulatus Uhler, on *Chenopodium album* (Bassett & Crompton, 1978b)
Melanotrichus flavosparus Sahlb., on *Chenopodium album* (Bassett & Crompton, 1978b); on *Chenopodium album* and *Beta vulgaris* (Knight, 1941)
Reuteroscopus ornatus (Reuter) on *Chenopodium album* (Knight, 1941)
Reuteroscopus sulphureus (Reuter) on *Chenopodium album* (Knight, 1941)
Tingitidae
Corythaica venusta (Champion) on *Salsola pestifer* (Drake, 1965)
Derephysia foliacea (Fallén) on *Chenopodiu*m (Drake, 1965)
Orthotylus flavosparsus (Sahlb.), on *Chenopodium album* (Leonard, 1928)
Piesmatidae
Piesma cinereum (Say), food: *Chenopodium album* (Leonard, 1928), found on pigweed and many other plants, occurs throughout the US (Arnett, 1985)

HOMOPTERA

Aphidae
Aphis abbreviata Patch, feeding on *Chenopodium album* (Bassett & Crompton, 1978b)
Aphis brevisiphona Theobald, on *Beta vulgaris* and *Chenopodium* (Patch, 1938)
Aphis evonymi Fabricius on *Atriplex*, and *Beta vulgaris*, *Amaranthus retroflexus* (Patch, 1938)
Aphis fabae Scop., Bean Aphid, feeds on *Chenopodium album* (Bassett & Crompton, 1978b)
Aphis gillettei Cowen on *Amaranthus retroflexus* (Patch, 1938)
Aphis gossypii Glover, Cotton Aphid, feeds on *Chenopodium album* (Bassett & Crompton, 1978b)
Aphis helianthi Monell on *Amaranthus* (Patch, 1938)
Aphis laburni Kaltenbach, feeds on *Chenopodium album* (Bassett & Crompton, 1978b); on *C. album* and *Bassia hyssopifolia* (Patch, 1938)
Aphis maidi-radicis Forbes, feeds on *Chenopodium album* (Bassett & Crompton, 1978b); on *Amaranthus hybrids*, *A. retroflexus*, *A. spinosus* and *C. album* (Patch, 1938)
Aphis medicaginis Koch, feeds on *Chenopodium album* (Bassett & Crompton, 1978b); on *Amaranthus*, *Chenopodium album*, *Bassia scoparia*, and *Salsola pestifer* (Patch, 1938)

Aphis middletonii (Thomas), Erigeron Root Aphid, feeds on *Chenopodium album* (Bassett & Crompton, 1978b); on *Chenopodium album* and *Amaranthus retroflexus* (Patch, 1938)
Aphis ochropus Koch. on *Chenopodium polyspermum* (Patch, 1938)
Aphis papaveris Fab., feeds on *Chenopodium album* (Bassett & Crompton, 1978b); on *Beta vulgaris* and *Chenopodium album* (Patch, 1938)
Aphis rumicis L., feeds on *Chenopodium album* (Bassett & Crompton, 1978b); on *Atriplex hortensis*, *A. patula*, *Beta vulgaris*, *Chenopodium album*, *C. ambrosioides*, *C. polyspermum*, *Spinacea oleracea*, *Amaranthus retroflexus* (Patch, 1938)
Aphis spiraecola Patch, feeds on *Chenopodium album* (Bassett & Crompton, 1978b); on *C. album*, *C. ambrosioides*, and *Amaranthus* (Patch, 1938)
Bipersona torticauda Gillette on *Salsola pestifer* (Patch, 1938)
Forda betae Westwood on *Beta vulgaris* (Patch, 1938)
Hayhurstia atriplicis L., on *Chenopodium album* (Bassett & Crompton, 1978b)
Hyalopterus atriplicis L., feeds on *Chenopodium album* (Bassett & Crompton, 1978b); *Atriplex hastatum*, *A. hortensis*, *A. patula*, *Beta vulgaris*, *Chenopodium album*, *C. hybridum*, *C. murale*, *C. polyspermum*, *C. urbicum*, *C. vulvaria*, *Amaranthus paniculatus*, *A. retroflexus* (Patch, 1938)
Macrosiphum gei Koch, feeds on *Chenopodium album* (Bassett & Crompton, 1978b); *Atriplex*, *Beta vulgaris*, *Chenopodium album*, *Cycloloma atriplicifolia*, *Spinacea* (Patch, 1938)
Macrosiphum solanifolii Ashmead, feeds on *Chenopodium album* (Bassett & Crompton, 1978b); *Atriplex*, *Beta vulgaris*, *Chenopodium album*, *Spinacea oleracea*, *Amaranthus retroflexus*, *A. spinosus* (Patch, 1938)
Macrosiphum sonchi L. on *Beta vulgaris*, *Chenopodium* (Patch, 1938)
Macrosiphum schranki Theobald on Amaranthus *(Patch*, 1938)
Myzus persicae (Sulzer), green peach aphid, feeds on *Chenopodium album* (Bassett & Crompton, 1978b), *Amaranthus retroflexus* is an alternate host in peach and apple orchards in Washington State (Weaver & McWilliams, 1980); on *Atriplex*, *Beta vulgaris*, *Chenopodium album*, *C. murale*, *C. viride*, *Salsolakali*, *Salsola tragus*, *Spinacea oleracea*, *Amaranthus* (Patch, 1938)
Myzus pseudosolani Theobald, feeds on *Chenopodium album* (Bassett & Crompton, 1978b); on *Chenopodium album*, *Amaranthus hybridus*, and *A. retroflexus* (Patch, 1938).
Pemphigus balsamiferae Williams on *Beta vulgaris* (Patch, 1938)
Pemphigus betae Doane, feeds on lamb's quarters (Bassett & Crompton, 1978b); on *Beta vulgaris* and *Chenopodium album* (Patch, 1938)
Pemphigus bursarius L. on *Chenopodium* (Patch, 1938)
Pemphigus lactucae Fitch on *Beta vulgaris* (Patch, 1938)
Pemphigus erigeronensis on *Beta vulgaris* (Patch, 1938)
Semiaphis dauci Fabricius on *Chenopodium* (Patch, 1938)
Thecabius affinis Kaltenbach on *Chenopodium* (Patch, 1938)
Trifidaphis perniciosa Nevsky on *Beta*, *Chenopodium* (Patch, 1938)
Trifidaphis phaseoli Passerini on *Beta*, *Amaranthus "graecizans"* (native *A. albus* complex), *A. retroflexus* (Patch, 1938)
Trifidaphis radicicola on *Beta* and *Chenopodium* spp.
Xerophilaphis plotnikovi Nevsky on *Beta vulgaris* (Patch, 1938)
Xerophilaphis salsolacearum Nevsky on *Salsola* (Patch, 1938)

Cicadellidae

Eutettix tenella, (leaf-hopper that carries the curly-top disease of the sugar-beet) host plant.

LEPIDOPTERA

Lycaenidae

Brephidium exilis (Boisduval) on *Atriplex patula*, *A. prostrata*, *Chenopodium* (Tietz, 1972)
Plebulina emigdionis (Grinnell) on *Atriplex* sp. (Tietz, 1972)

Sphingidae

Hyles lineata (Fab.) on *Beta vulgaris*, *Chenopodium*, *Amaranthus* (Tietz, 1972)

Arctiidae

Apantesis arge (Drury) on *Chenopodium* (Tietz, 1972)
Apantesis virgo (L.) on *Chenopodium* (Tietz, 1972)
Diacrisia virginica (Fab.) on *Beta vulgaris*, *Amaranthus* (Tietz, 1972)
Estigmene acrea (Drury) on *Beta vulgaris*, *Amaranthus spinosus* (Tietz, 1972)

Isia isabella (Abbott & Smith) on *Beta vulgaris* (Tietz, 1972)

Coleophoridae

Coleophora amaranthella Braun, feeds on seed of *Amaranthus hybridus* (Forbes, 1923)

Coleophora annulatella Tengstr., larva eats seeds of *Chenopodium* spp. and *Atriplex* spp. (Bassett & Crompton, 1978b)

Coleophora lineapulvella (Chambers), severe seed predation on *Amaranthus retroflexus* and *A. hybridus* (Weaver & McWilliams, 1980).

Gelechiidae

Chrysopora hermannella Fab., on *Chenopodium* (Leonard, 1928), (Forbes, 1923)

Chrysopora lingulacella Clemens, on *Chenopodium* (Forbes, 1923)

Chrysoesthia hermonella Fab., on *Chenopodium album* (Bassett & Crompton, 1978b)

Gnorimoschema chenopodiella Bsk., *Chenopodium* (Leonard, 1928)

Scrobipalpa absaletella Fisch. v. Rossl., mines leaves of *Chenopodium album* (Bassett & Crompton, 1978b)

Scrobipalpa atriplicella Fisch. v. Rossl., on *Chenopodium album* (Bassett & Crompton, 1978b)

Scrobipalpa nitentella Fuchs, eats flowers and seeds of *Chenopodium album* (Bassett & Crompton, 1978b)

Hesperiidae

Erynnis martialis (Scudder) on *Amaranthus* sp., *A. retroflexus* (Tietz, 1972)

Pholisora catullus (Fab.), Sooty-wing, *Chenopodium album*, *Amaranthus* (Leonard, 1928), larvae feed on lamb's quarters, other Chenopodiaceae and Amaranthaceae (Arnett, 1985); on *Amaranthus* (Tietz, 1972)

Pyralidae

Blepharomastix ranalis Guen., *Chenopodium* (Leonard, 1928) (Forbes, 1923)

Herpetogramme bipunctalis (Fab.) on *Beta vulgaris* (Forbes, 1923)

Hymenia fascialis Cr., Hawaiian Beet-webworm, beet, chard, *Amaranthus*, and various weeds (Leonard, 1928); *Beta vulgaris* and *Amaranthus* (Forbes, 1923)

Hymenia perspectalis (Hbn.), Spotted Beet Webworm, larva on Beet and chard (Leonard, 1928), larvae feed on beets, chard (Arnett, 1985); on *Beta vulgaris* (Forbes, 1923)

Loxostege sticticalis (L.), Sugar-beet Webworm (Leonard, 1928), larvae general feeders, including on cultivated plants (Arnett, 1985) (Forbes, 1923)

Ostrinia nubilalis (Hb.), European Corn Borer, *Amaranthus retroflexus* is severely attacked (Weaver & McWilliams, 1980)

Geometridae

Eupithecia subnotata Hb., larvae feed on flowers and seeds of *Chenopodium album* (Bassett & Crompton, 1978b)

Noctuidae

Agrotis ipsilon (Hufnagel), Black Cutworm Moth, larvae can survive and pupate on *Amaranthus retroflexus* in Indiana (Weaver & McWilliams, 1980); on *Beta vulgaris* (Tietz, 1972)

Agrotis malefida Guenee on *Beta vulgaris* (Tietz, 1972)

Agrotis orthogonia (Morrison) on *Beta vulgaris* (Tietz, 1972)

Agrotis subterranea (fab.) on *Beta vulgaris*, *Amaranthus* (Tietz, 1972)

Anicla infecta (Ochsenheimer) on *Beta vulgaris* (Tietz, 1972)

Apamea devastator (Brace) on *Beta vulgaris* (Tietz, 1972)

Autographa californica (Speyer), Alfalfa Looper, larvae have been collected on *Amaranthus* sp. in California (Weaver & McWilliams, 1980); on *Beta vulgaris* (Tietz, 1972)

Autographa falcifer Kirby on *Beta vulgaris* (Tietz, 1972)

Autographa ni (Hubner) on *Beta vulgaris* (Tietz, 1972)

Autoplusia egena (Gn.), Bean Leaf Skeletonizer, larvae have been collected on *Amaranthus* sp. in California (Weaver & McWilliams, 1980)

Euxoa auxiliaris (Grote) on *Beta vulgaris* (Tietz, 1972)

Euxoa laetificans (Smith) on *Beta vulgaris* (Tietz, 1972)

Euxoa messoria (Harris) on *Beta vulgaris* (Tietz, 1972)

Euxoa munis (Grote) on *Beta vulgaris* (Tietz, 1972)

Euxoa ochrogaster (Guenee) on *Beta vulgaris* (Tietz, 1972)

Euxoa tessellata (Harris) on *Beta vulgaris* (Tietz, 1972)

Euxoa tristicula (Morrison) on *Beta vulgaris* (Tietz, 1972)

Heliothis zea (Boddie) on *Amaranthus* sp. (Tietz, 1972)

Mamestra configurata Walker on *Beta vulgaris* (Tietz, 1972)

Melanchra picta (Harris) on *Beta vulgaris* (Tietz, 1972)

Ochropleura plecta (L.) on *Beta vulgaris* (Tietz, 1972)
Papaipema nebris (Guenee) on *Beta vulgaris* (Tietz, 1972)
Peridroma margaritosa (Haworth) on *Beta vulgaris* (Tietz, 1972)
Pseudaletia unipuncta (Haworth) on *Beta vulgaris* (Tietz, 1972)
Scotogramma trifolii (Rottenburg), feeds on young plants of *Chenopodium album* (Bassett & Crompton, 1978b); on *Beta vulgaris* (Tietz, 1972)
Spodoptera eridania (Cramer) on *Beta vulgaris*, *A. retroflexus* (Tietz, 1972)
Spodoptera exigua (Hubner) on *Beta vulgaris*, *Atriplex* sp., *Amaranthus retroflexus* (Tietz, 1972)
Spodoptera frugiperda (Abbot & Smith) on *Beta vulgaris* (Tietz, 1972)
Spodoptera ornithogalli Guenee on *Beta vulgaris*, *Amaranthus retroflexus*, *A. spinosus* (Tietz, 1972)
Spodoptera praefica Grote on *Beta vulgaris* (Tietz, 1972)
Trichoplusia ni Hb., Cabbage Looper, larvae have been collected on *Amaranthus* species in California (Weaver & McWilliams, 1980)
Xestia c-nigrum (L.) on *Beta vulgaris* (Tietz, 1972)

DIPTERA

Agromyzidae
Agromyza pusilla Meig., on *Amaranthus viridis* (Cuba), *Beta vulgaris*, *Spinacia oleracea* (North America) (Frost, 1923)
Agromyza scutellata Fall., *Chenopodium botrys* (NA) (Frost, 1923)
Phytomyza affinis Fall., *Spinacia oleracea* (Europe) (Frost, 1923)
Phytomyza albiceps Meig., on *Atriplex sp* (Europe) (Frost, 1923)
Drosophilidae
Scaptomyza adusta Loew, on *Amaranthus retroflexus* (NA) (Frost, 1923)
Scaptomyza graminium Fall., *Chenopodium album* (Europe) (Frost, 1923)
Ephydridae
Hydrellia leucotoma Meig, *Chenopodium album* (Europe) (Frost, 1923)
Oscinidae
Chlorops assimilis Macq., *Beta vulgaris* (Europe) (Frost, 1923)
Anthomyiidae
Hylemyia betarum Lint., *Beta vulgaris* (NA) (Frost, 1923)
Hylemyia floccosa Macq., *Beta vulgaris* (NA) (Frost, 1923)
Hylemyia fugax Meig., host plants: *Amaranthus retroflexus*, *Beta vulgaris*, *Chenopodium album*, *Spinacia oleracea* (NA) (Frost, 1923)
Hylemyia substriata Stein., *Beta vulgaris*, *Beta vulgaris* var. *macrorhiza* (NA) (Frost, 1923)
Pegomyia betae (Curtis), Beet Leaf Miner, Spinach Leaf Miner, this species mines the leaves of beets, spinach, and similar plants (Arnett, 1985)
Pegomyia hyoscyami Panz., Spinach Leaf Miner, larvae mine leaves of beet, spinach, *Chenopodium* (Leonard, 1928); *Amaranthus retroflexus*, *Atriplex hortensis*, *Atriplex patula*, *Beta vulgaris* (NA), *Beta vulgaris* var. *macrorhiza* (Europe), *Chenopodium album* (NA), *Chenopodium muarale* (Europe), *Spinacia oleracea* (NA) (Frost, 1923)
Pegomyia nigritarsis Zett., *Atriplex patula*, *Beta vulgaris*, *Chenopodium album* (Europe) (Frost, 1923)
Pegomyia ruficeps Stein, *Beta vulgaris* (NA) (Frost, 1923)
Pegomyia sulcans Rond., *Chenopodium* sp. (Europe) (Frost, 1923)

COLEOPTERA

Chrysomelidae
Systena frontalis (Fr.), Red-headed Flea Beetle, *Amaranthus retroflexus* is a major food plant of the fleabeetle in Iowa (Weaver & McWilliams, 1980)
Curculionidae
Cosmobaris americana Casey, reported to attack members of the Amaranthaceae as well as sugar beets throughout the United States (Weaver & McWilliams, 1980)

HYMENOPTERA

Braconidae

Agathirsia sancta (Say), host is *Pholisora catullus*, the larvae of which are known to devour goosefoot or pigweed (*Chenopodium*) and amaranth (*Amaranthus*) (Viereck, 1916)

Apanteles trachynotus Viereck, claims to have been reared from *Pegomyia vicina*, infesting *Chenopodium* (Viereck, 1916)

Microbracon auripes (Prov.), a parasite of lepidopterous larvae boring in such weeds as *Amaranthus* (Leonard, 1928)

Microplitis mamestrae Weed., parasitic upon the painted mamestra (*Mamestra picta*), the larva of which is especially destructive to cabbages and beets (Viereck, 1916)

Eulophidae

Sympiesis chenopodii Ashmead, reared from a *Lithocolletis* miner of *Chenopodium hybridum* (Viereck, 1916)

Apoidea

Andrena piperi Viereck visits flowers of *Salsola kali* (Krombein *et al.*, 1979)

Dianthidium dubium dilectum Timberlake visits flowers of *Chenopodium* (Krombein *et al.*, 1979)

Dianthidium subparvum Swenk. visits flowers of *Chenopodium* (Krombein *et al.*, 1979)

Hylaeus bisinuatus Forster visits flowers of Amaranthaceae (Krombein *et al.*, 1979)

Hylaeus conspicuus (Metz.) Wash. visits flowers of *Salsola kali* (Krombein *et al.*, 1979)

Megachile policaris Say. visits flowers of *Salsola* (Krombein *et al.*, 1979)

Megachile sidalceae Cockerell visits flowers of *Salsola* (Krombein *et al.*, 1979)

Megachile wheeleri Sask. visits flowers of *Chenopodium* (Krombein *et al.*, 1979)

Melissodes coreopsis Robertson visits flowers of *Salsola pestifer* (Krombein *et al.*, 1979)

Melissodes paulula LaBerge visits flowers of *Salsola kali* (Krombein *et al.*, 1979)

Melissodes subagilis Cockerell visits flowers of *Salsola kali* (Krombein *et al.*, 1979)

Melissodes tepida timberlakei Cockerell visits flowers of *Salsola kali* (Krombein *et al.*, 1979)

Melissodes tristis Cockerell visits flowers of *Salsola kali* and *S. pestifer* (Krombein *et al.*, 1979)

Nomia melanderi Cockerell visits flowers of *Beta vulgaris* and *Salsola kali* (Krombein *et al.*, 1979)

Perdita calloleuca calloleuca Cockerell. visits flowers of *Salsola kali* (Krombein *et al.*, 1979)

Perdita calloleuca convergens Timberlake visits flowers of *Suaeda* (Krombein *et al.*, 1979)

Perdita zebrata flavens Timberlake visits flowers of *Salsola kali* (Krombein *et al.*, 1979)

APPENDIX III

MISCELLANEOUS PARASITES

Nematodes

Aphelenchoides fragariae (Ritz.-Bos), on *Amaranthus* spp. (Weaver & McWilliams, 1980)
Ditylenchus dipsaci (Kuehn) Filip., on *Chenopodium album* (Bassett & Crompton, 1978b)
Heteroda Marioni (Cornu) A. Schm., on *Amaranthus* spp. (Weaver & McWilliams, 1980)
Meloidogyne raedicicola (Greef.), on *Amaranthus* spp. (Weaver & McWilliams, 1980)
Meloidogyne sp., on *Chenopodium album* (Bassett & Crompton, 1978b) .
Pratylenchus pratensis (DeMan) Filip., on *Amaranthus* spp. (Weaver & McWilliams, 1980), on *Chenopodium album* (Bassett & Crompton, 1978b)

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Portulacaceae through Caryophyllaceae of New York State

RICHARD S. MITCHELL
New York State Museum

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Richard S. Mitchell, Editor

1993

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The University of the State of New York
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PREFACE

OUR GOAL in producing this series is to present a useful and authoritative account of the plants of New York State. These contributions are intended to reflect the knowledge and taxonomic opinions of specialists who prepare the manuscripts while following a generalized format for consistency. Inclusion of ecological, distributional, medical and economic information on each species is also one of our major aims. Habitat references, flowering times, pertinent synonymy, etc., often apply specifically to New York plants rather than to the entire species. Illustration of all species should facilitate identification of specimens for those who are not formally trained in botany. Descriptions are original, ordered and as complete as possible to provide sequential cross-referencing.

Distribution maps accompany species of seed plants, ferns, mosses, lichens and some groups of fungi. These are plotted by counties to avoid pinpointing endangered habitats, while offering an accurate visual picture of past collecting. Maps are based on the master file at the New York State Museum, Albany, and supplemented by available data (specimens examined by the authors) from herbaria housing significant New York collections. Data or literature citations for any map may be obtained, on approval, from the Museum. We hope that these bulletins will serve individuals with interest in the flora, as well as to provide information for State and Federal agencies, conservation organizations, industry and the scientific community. With these works go our hopes for preservation and wise use of a precious and lifegiving resource--our State's plant life.

The New York State Flora Committee

The steering council of the New York State Flora Committee met for the first time on January 19, 1976, and established as its goals the promotion of study of the State's plant resources and the publication of this series of museum bulletins. These contributions will be continually updated after publication for possible incorporation into larger volumes at a later date.

CONTENTS

ACKNOWLEDGMENTS

The illustrations in this treatment are by Bobbi Angell, whose botanical knowledge and extensive use of fresh plant materials for the illustrations have added immensely to the value of the work. My special thanks go to Richard K. Rabeler who generously shared his bibliographic and botanical knowledge of the Caryophyllaceae, contributing significantly to the quality of this volume. He also added distribution records from specimens observed at the Hoysradt Herbarium, Hartwick College, NY (HHH), and the University of Michigan (MICH). I would like to express my appreciation to the staffs and curators of the following institutions for helpful cooperation and hospitality when I visited their collections: The New York Botanical Garden (NY), Cornell University (CU, BH), Syracuse University (SYRF), Harvard University (GH, NEBC), and The Buffalo Museum of Science (BUF). Thanks to the staff of the Brooklyn Botanic Garden (BKL) for a loan of their Caryophyllaceae from New York State. Data from the above collections were entered into computers for later use in the GIS system and to update the master map-files of plant distribution at the New York State Museum (NYS). The classification system employed here is that of Arthur Cronquist (1981).

IMPORTANT NOTE

All economic uses, folklore, medical and pharmaceutical notes, uses as foodstuffs, etc., are compiled from the literature and do not represent an endorsement by the authors or the New York State Museum. Some of the uses may, indeed, be dangerous if incorrectly employed. Some are not effective and are presented for historical interest only.

FOR ALL MAPS IN THE PUBLICATION
THE FOLLOWING SYMBOLS APPLY

Solid dot---specimen seen by author: data on file at the State Herbarium (NYS)
Circle---field or herbarium observation not seen by author, with location data and observer's name or literature citation on file (NYS)

Portulacaceae (Purslane Family)

The Portulacaceae: a family of almost cosmopolitan distribution with about 20 genera and over 450 species. By far, the largest numbers of species belong to four genera: *Talinum* (ca. 50), well represented in western North America, with a few species in the midwestern and southeastern states; *Anacampseros* of Africa, with about 60 species; *Portulaca*, with over 100 species, some of which have horticultural significance; and *Calandrinia*, the largest genus, with 150 species or more. Diversity within the family is greatest in western North America and southern South America. In New York State, two native *Claytonia* species occur, and two portulacas are found as naturalized garden escapes.

FAMILY DESCRIPTION

Annual or perennial herbs or suffrutescent shrubs; stems sometimes succulent. Perennial species proliferate by stolons, rhizomes, bulblets or corms. Leaves are opposite, alternate, crowded at the bases of flowers (or clusters) or in basal rosettes, almost always simple and entire and often somewhat fleshy. Stipules are dry or setiform (absent in *Claytonia*). Flowers are bisexual (rarely unisexual), borne in racemes, cymes, panicles or loose heads, usually regular, the perianth of two series; tepals are free or slightly connate at base, the inner series often called petals, though they are interpreted morphologically as tepals subtended by involucral bracts. The petals (inner tepals) are 2-6 (-20), deciduous or persistent, white or variously colored; sepals (outer tepals or bracteoles) are 2 (-9), green or suffused with color. The stamens are borne opposite the petals, equal in number (or 2-4 times the number, by splitting). The anthers dehisce by longitudinal slits; filaments are free or basally adnate to a short tube, often associated with nectaries or a nectary ring. The gynoecium is free or slightly adnate to the perianth, a compound ovary with 2-3 (-9) carpels and free styles (or a single lobed style). The developing ovary becomes unilocular with free central placentation, ripening into a circumscissile capsule or loculicidal capsule with lateral (or apical) valves, or it is rarely an indehiscent nut. Ovules are 2 to many (rarely 1), bitegmic and variously disposed but often basal; seeds are frequently lenticular, shiny or tubercled, bearing a large embryo peripherally, curved around a copious, starchy perisperm.

KEY TO GENERA

1. Capsule dehiscing by a lid; flowers closely subtended by leaves, whether borne singly or in small clusters; annuals with weak root systems . . . . 1. *Portulaca*
1. Capsule dehiscing by vertical valves; flowers borne in slender, naked racemes or cymes (occasionally a single flower on a peduncle); perennials with corms or runners . . . . (2)
   2. Cauline leaves almost always borne in a single pair; stems arising from a deep corm, 1-many, ascending or prostrate at ground level, but not laterally branched upward or spreading by stolons . 2. *Claytonia*
   2. Cauline leaves commonly more than 2; stems branching upward, proliferating by slender stolons at their bases . . . . [*Montia*][1]

---

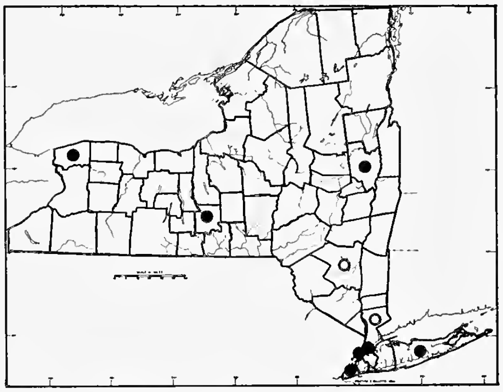
[1]*Montia chamissoi* (Esch. ex Ledeb. in Spreng.) Dur. & Jacks. is reported from two sites in Pennsylvania, where it occurs on the banks of the Delaware River, only yards from the New York State border. Suitable habitats have not been found in searches on the New York side, but the plants may eventually be discovered there. *Montia chamissoi* is primarily a western species, distributed from Alaska to California, Iowa and Minnesota. Pennsylvania populations are likely relics of eastward postglacial migrations, though their native status has been questioned. Two other species of *Montia* have been reported as introduced in the eastern United States; however, the pattern of distribution of *M. chamissoi* is reminiscent of those of other western taxa, like *Adoxa moschatellina* L. and *Juncus ensifolius* Wikst., disjunct from northern-central states to southeastern upstate New York.

1. PORTULACA

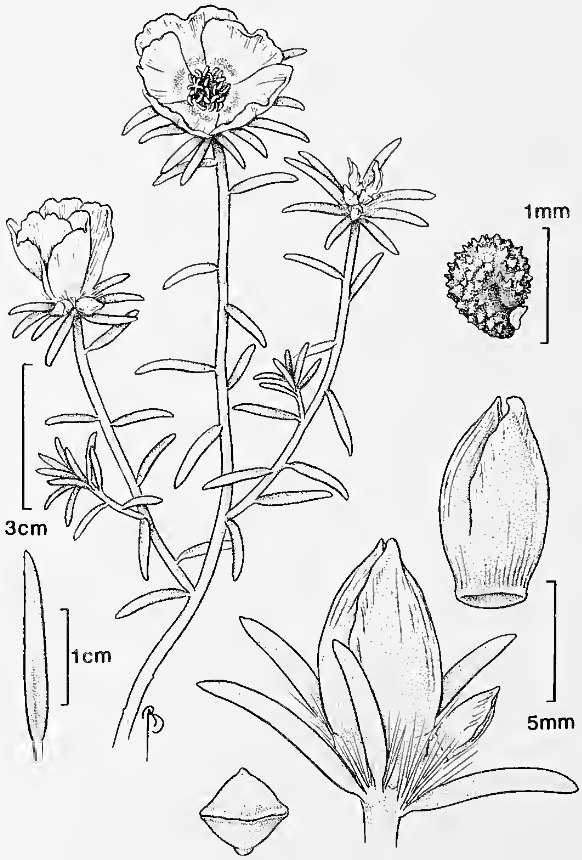
Common Names: Purslane, Portulaca
Authority: Linnaeus, Species Pl. I, p. 445, 1753
A genus of 100-130 species worldwide, distributed mostly in the drier regions of the subtropics and tropics as well as in Mediterranean and Austral climates. Several species are cultivated and popular in rock gardens.
Description: Plants with **bisexual** flowers; **stigmas** at the **style** branches, often deeply cleft; **ovary** 1, often partially inferior, with many campylotropous **ovules** borne on a basal placenta; **fruit** a circumscissile capsule; **seeds** numerous with curved **embryos** and a starchy **perisperm**; **stamens** 5-many; **filaments** slender; **anthers** often globose; **perianth** of 2 whorls; **petals** (tepals) free or coherent into a short tube, 5-many; **sepals** (bracteoles) usually 2, free, accrescent, green or suffused with color; **pedicels** sometimes present; **peduncle** present or flowers sessile; **bracts** often present in the inflorescence; **inflorescences** of various types of clusters or flowers solitary; **leaves** opposite, alternated or whorled, particularly subtending flowers or flower clusters, often semisucculent, broad to linear and terete; **petioles** well defined to lacking; **stipules** scarious, often minute; **stems** usually glabrous, dry to succulent, creeping to erect; **root systems** often shallow.

KEY TO SPECIES

1. Leaves mostly linear, quite succulent, broadly oval to terete in cross-section; stamens 20-40 or more; flowers showy, ca. 2-4 cm broad, red, pink, yellow, orange, purple or white . . . . 1. *P. grandiflora*
1. Leaves obovate to spatulate, succulent but flattened; stamens 7-12; flowers ca. 1 cm broad, yellow . . . . 2. *P. oleracea*



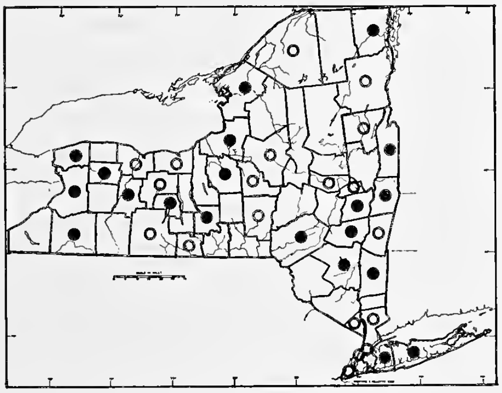
1. *Portulaca grandiflora* Hook.
Common Names: Moss-rose, Rose-moss, Common or Garden Purslane, Sun- plant, Eleven-o'clock, Portulaca
Type Description: Hooker, Bot. Mag., vol. 56, pl. 2885, 1829
Origin: A native of South America
Habitats: A garden escape on dry, gravelly or rocky soils, lake shore sands, cultivated ground and other disturbed areas
Habit: Annual, creeping and ascending herbs
Flowering: (May) June-September
Fruiting: June-November
General Distribution: Commonly escaping from cultivation south of our area, but rare from New Jersey northward

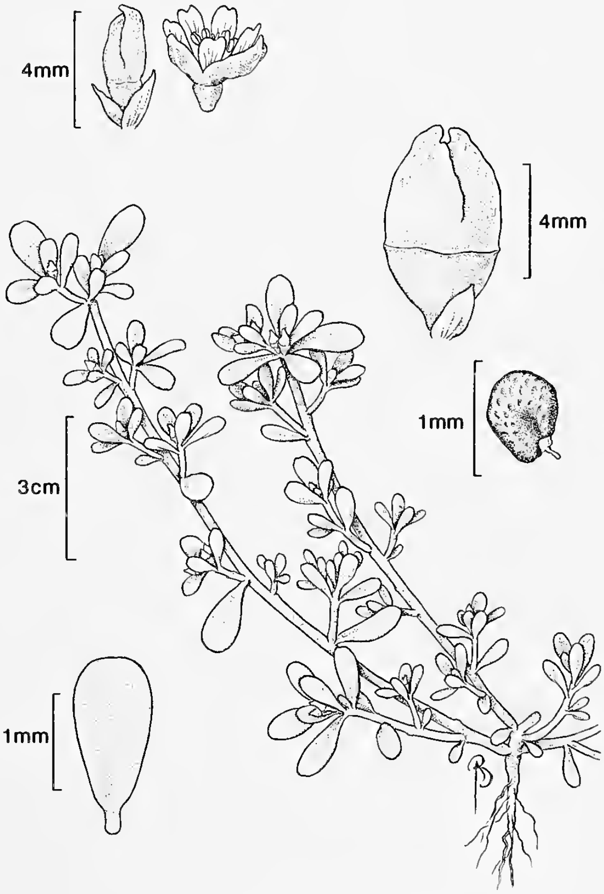


Description: Plants with **bisexual** flowers; **stigmas** 5-10, often 8, diverging lobes, spatulate or lacerate, 1.5-2.2 mm long, ca. 0.5 mm broad; **style** 1, tubular, 0.6-2.3 cm long, reddish-brown or the same color as the perianth; **ovary** ovate, ca. 2 mm long, often surrounded by a shallow, perigynous perianth cup; **fruit** a circumscissile capsule with a corky suture at its circumference, spheroid, 4-7 mm long and broad, the common style base persistent as a nipple at the apex, capsule surface glossy, greenish-tan to burnished or golden-brown; **seeds** many, ca. 0.7 mm long, 0.5 mm broad, comma shaped, the surfaces prominently tuberculate, dark brown with an opalescent sheen; **stamens** numerous, 5-7 (9) mm long; **anthers** minute, golden or colored like the flower; **filaments** thread-like, arched, adnate to the petal bases dark rose to pale; **perianth** of two whorls (sometimes interpreted as tepals and bracteoles); **petals** 4-6 (multiple in most cultivars), red, rose-purple, white or yellow, often striped, 1.3-3.5 (4) cm long, 0.4-2.8 cm broad at tips, obovate to obspatulate or truncate-emarginate, the tips lobed, wavy or lacerate, bases cuneate, free or fused into a short cup, subtended by a dense tuft of woolly to villous hairs; **sepals** 4-12, similar to the leaves but less succulent and flatter with distinct lower midribs, greenish with hyaline margins, linear with blunt tips, 4-13 mm long, 0.7-1.2 mm broad, subtended by tufted, villous hairs; **flowers** sessile, borne singly, usually on upwardly arching lateral branches; **leaves** alternate, succulent, linear-lanceolate, broadly oval to subterete in cross-section, with blunt to acute tips, 5-25 (32) mm long, 1-4 (6) mm broad, rich green with paler bases, the surfaces translucent-muricate; **petioles** ca. 1 mm long with minute, hyaline wings; **stems** semisucculent to coarsely fibrous near the base, creeping or suberect, with upwardly arching lateral branches to 25 (31) cm tall; **root system** a shallow, annual taproot with coarsely fibrous lateral roots (2n = 10, 18; artificial polyploids are known in cultivation).

Infraspecific Variation: The moss-rose is extremely variable in flower size and color, sometimes even bearing striped or multicolored flowers. Dwarf mutants are known, and these variants may also have very broad leaves.

Importance: The moss-rose is widely cultivated in sunny, tropical and temperate climates; it thrives in areas with Mediterranean dry summers and moist winters. Used as a rock garden or beachfront plant, it can provide a variety of brilliant colors to otherwise sandy or rocky, barren spots in full sun.





2. *Portulaca oleracea* L.

Common Names: Garden or Kitchen Purslane

Type Description: Linnaeus, Species Pl. I, p. 445, 1753

Origin: Eurasian, its native range unknown

Habitats: A common weed in gardens, less commonly naturalized in fields, land fills and other disturbed areas, and occasionally found in calcareous, open habitats with native flora

Habit: Annual, sprawling, prostrate to weakly ascending, succulent herbs forming mats

Flowering: July-October

Fruiting: Aug.-November

General Distribution: Naturalized and weedy across the United States, southern Canada and elsewhere around the world, including Eurasia, where it is also native

Description: Plants with **bisexual** flowers, ephemeral, usually opening only on sunny mornings; **stigmas** as many as the style branches; **style** 1, deeply (3) 4-6 cleft; **ovary** fusiform, unilocular, minute; **fruit** a smooth, circumscissile capsule, 5-7 mm long, 3-4 mm broad, ovoid, acute at the tip, the valve prominent, dehiscing along the circumference just below the middle of the capsule, the base remaining, cup-like, with a prominent tuft of funiculae at its center after seed-scatter; **seeds** 8-12 or more, ca. 0.7 mm long, 0.5 broad, dark brown, shiny with muricate to bluntly-tubercled surfaces and a small, pale caruncle; **stamens** 7-12; **anthers** golden, minute; **filaments** linear; **perianth** of two whorls, appearing epigynous from capsule suture in fruit; **petals** 4-5, yellowish, their limbs ovate, sometimes lobed or fimbriate at tips, 2-5 mm long and broad (or up to 1 cm in some cultivars); **sepals** 2, ca. 3 cm long and broad, greenish, persistent, enclosing the capsule lid in fruit and forming a keel-like projection beyond its tip; **peduncles** very short, virtually absent; **inflorescences** small clusters of subsessile flowers or flowers solitary; **bracts** subtending the flowers and clusters variable in size and shape ranging from leaf-like cordate-cuspidate bracts ca. 1 mm in diameter to minute, linear structures, with tufts of a few thick hairs in their axils; **leaves** semisucculent, alternate, subopposite or whorled at the branch tips below the flower clusters, spatulate to truncate or emarginate-tipped, cuneate toward the base, ranging from minute and bract-like up to 2-3 cm long, 1.5 cm broad, sometimes with tufts of hairs in their axils, (leaves) sessile or **petioles** poorly defined, up to 6 mm long; **stipules** lanceolate, 1-2 mm long; **stems** somewhat succulent, often much-branched, with many short, lateral shoots, prostrate to weakly ascending at the tips, the **nodes** sometimes enlarged, red, **internodes** short near the branch tips, up to 8 cm long near the plant base, greenish to red, stems spreading and mat-forming, up to 50 cm long; **root system** fibrous, shallow, adventitious at the lower nodes with damage. ($2n = 28, 54$)

Infraspecific Variation: The cultivar, sometimes called ssp. *sativa* (Haw.) Celak., is robust, more succulent than its wild-growing counterpart, and the branches are ascending to erect, sometimes reaching 50 cm in height. Such plants known as garden escapes in Greene County, New York. Another cultivar (var. *giganthes* Bailey) has double flowers up to 2.5 cm in diameter. Flower colors other than yellow are known in cultivation, but, so far, these have not been reported as escapes within our range.

Importance: The 'Giganthes' cultivar of this species, with flowers up to an inch broad, is grown as an ornamental, while the more erect, succulent *P. oleracea* cv. Sativa, is well known as a cultivated salad and pot herb, variously called kitchen purslane (purselane), garden purslane or pusley. It is eaten raw, boiled or fried in grease, or pickled and stored for winter use. The weedy form of the plant is occasionally eaten as a salad herb, but rarely cultivated for that purpose. Purslane is known to be mildly diuretic, and the plants have been reported to concentrate dangerous levels of oxalate crystals. They are cited as a cause of oxalic acid poisoning when eaten in large quantities by sheep and other livestock. In folk medicine and kitchen lore, the plants are reputed to cure excessive thirst, dry throat and loose teeth. Purslane has been used in Europe and Asia in external medicinal applications, such as poultices for reduction of fever, soothing inflamed eyes, and as a packing for wounds. It contains significant amounts of Vitamin C, and there are reports of its use on 16th century sailing vessels to treat and prevent scurvy. *Portulaca oleracea* is also a carrier of the tomato spotted-wilt virus.

2. CLAYTONIA

Common Name: Spring Beauty

Authority: Linnaeus, Species Pl. I, p. 204, 1753

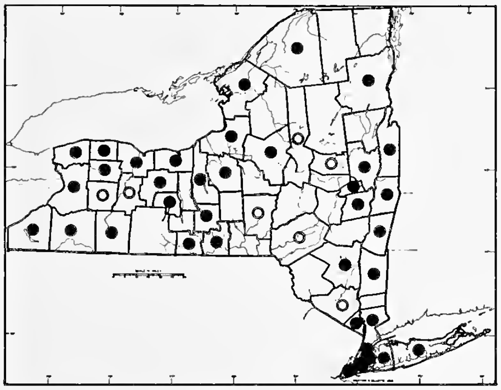
A genus of 15-20 species with its center of greatest diversity in western North America, but with species distributed from eastern North America to South America, Asia, Australia and New Zealand. Our two closely-related species are spring ephemerals of little horticultural value, but they are sometimes transplanted from the wild into gardens as a curiosity.

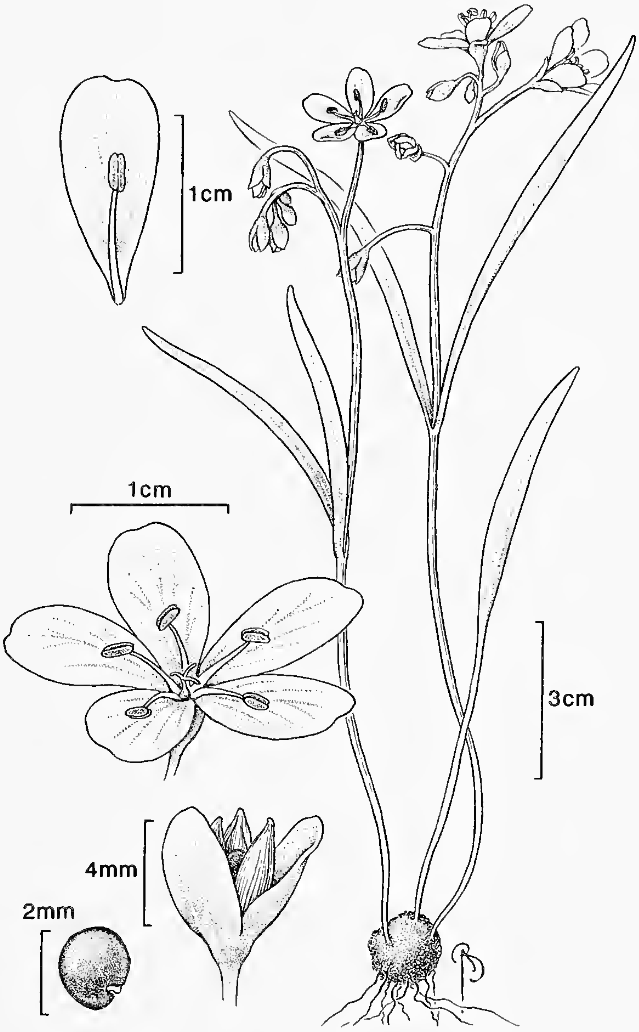
Description: Plants with **bisexual** flowers; **stigmas** 3, on the lobes of the style; **style** 1, 3-lobed at apex; **ovary** 1, superior, becoming unilocular, with 6 **ovules** borne on a central placenta; **fruit** a capsule, dehiscing by the inrolling of the margins of its 3 valves; **seeds** 1-6; **embryo** peripheral to a starchy **perisperm** (true endosperm lacking); **stamens** 5; **filaments** adhering to the petal claws; **anthers** elongate; **perianth** of two whorls; **petals** 5, free, clawed at base, oval to elliptic, spreading; **sepals** 2, accrescent; **pedicels** slender, bracteose, often lax

or recurved in fruit; **peduncles** slender to somewhat fleshy; **bracts** scarious or herbaceous; **leaves** usually one to several at the plant base, cauline leaves commonly borne as a single, opposite pair, linear to oval, rhombic or oblanceolate; **petioles** indistinct to well-developed; **stipules** absent; **stems** slender, 1-many, arising from a corm buried an inch or more beneath the soil surface; **root system** delicate to fibrous and wiry.

KEY TO SPECIES

1. Cauline leaves linear to narrowly oblanceolate, more than seven times longer than broad; petioles absent or poorly defined; capsule ovate, usually bearing 3 or more seeds; the lowermost inflorescence bract often greenish, herbaceous, succulent when fresh . . . . 1. *C. virginica*
1. Cauline leaves ovate to rhombic or broadly oblanceolate, fewer than seven times longer than broad, their petioles ± distinct; capsule cylindric-ovate, usually bearing a single seed; lowest inflorescence bract scarious . . . . 2. *C. caroliniana*





1. *Claytonia virginica* L.

Common Names: Spring Beauty, Mayflower, Grassflower, Rose Elf, Good-morning-spring, Wild Potato, Fairy-spuds

Type Description: Linnaeus, Species Pl. I, p. 204. 1753

Synonyms: *Claytonia media* (DC.) Link, not Small, *C. multicaulis* var. *robusta* Somes, *C. robusta* Rydb., *C. simsii* Sweet, *C. virginica* var. *acutiflora* DC., *C. virginica* var. *simsii* (Sweet) R. Davis

Origin: Native to eastern North America

Habitats: Moist woodlands thickets and stream banks often in litter, relatively sun-tolerant, persisting in fields after clearing

Habit: Perennial, ephemeral herbs with slender, decumbent to erect, semi-succulent stems arising from a corm

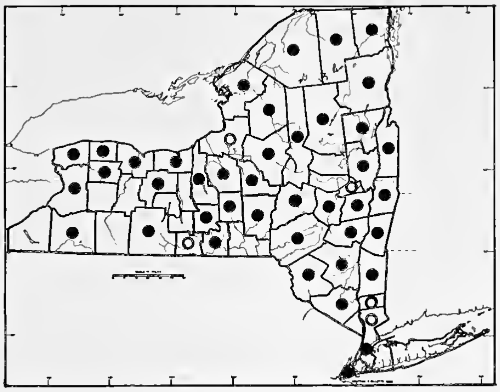
Flowering: (March further south) April-May

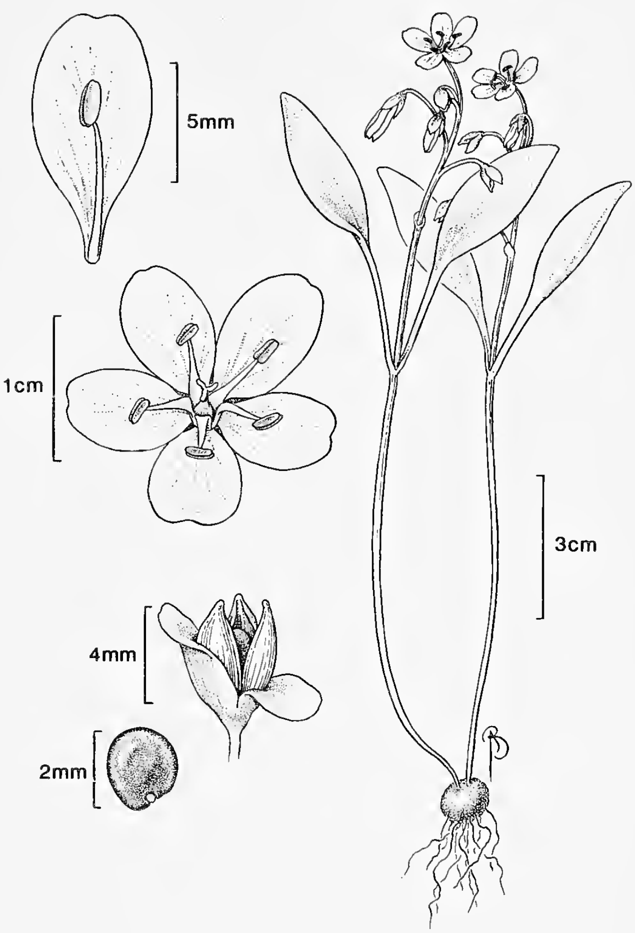
Fruiting: May-June (early July)

General Distribution: Southwestern Quebec and New England west to Minnesota and south to eastern Texas and Georgia

Description: Plants with **bisexual** flowers; **stigmas** 3, receptive at the tips and along the adaxial surfaces of short style branches; **style** 1, very slender, 4-7 (9) mm long, with 3 recurved, stigma-bearing branches 0.8-1.4 mm long at the tip; **ovary** ovoid, ca. 1.5 mm long and broad; **fruit** a tan capsule, ovoid to broadly cylindric with

an obtuse to acuminate tip, 3.5-5.5 mm long, 3.4-4.6 mm broad, enclosed in the persistent calyx, dehiscing by 3 vertical sutures and valves; **seeds** 3 (4-6), ovoid, ca. 2.5 mm long, 2 mm broad, slightly ribbed, the surface shiny, deep red-brown; **stamens** 5, opposite the petals; **anthers** 1.8-2.3 mm long, ca. 0.7 mm wide, golden to deep pink; **filaments** linear, pale, 2-4 mm long, adnate to petal claws at base; **perianth** of two series; **petals** (tepals) 5, slightly clawed at base, the linear-oblong to broadly ovate or obovate limbs spreading above the calyx, (3) 5-15 (23) mm long, 2-9 (11) mm broad, white or pink tinged to deep rose, the margins entire or erose at petal tips; **sepals** 2, accrescent, 3-15 (25) mm long, 3-19 mm broad, oval, cucullate, tips rounded to broadly acute (often appearing acute on pressing), glabrous, greenish, somewhat fleshy; **pedicels** glabrous, very slender, (0.2) 1-2 (3.2) cm long, elongating during flowering, drooping or reflexing in fruit; **peduncle** erect or ascending, glabrous, 2-35 (40) mm long, bearing a single raceme, or **inflorescence** branched into 2-4 raceme axes, up to 10 cm long with (2) 3-12 (20) flowers per plant; **bracts** present at the bases of some of the lower pedicels, the lowermost lance-ovate, 2-5 (10) mm long, 0.5-3.5 mm broad, often remaining green and herbaceous into the fruiting period; **cauline leaves** borne in a single, opposite pair (rarely terminal to a short, lateral shoot) strap-like, linear to lanceolate or oblanceolate, generally 7 times longer than broad or more, (2) 5-12 (16) cm long, (0.1) 0.2-1.3 (2.5) cm broad, glabrous with a rimmed, entire margin (rarely a small dentation), tips acute to quite blunt; **basal leaves** 0-2 (4), similar to cauline leaves when present; **petioles** obscure, poorly differentiated, grading imperceptibly into the leaf blade; **stems** (1) 2-25 (40), unbranched, slender and pale beneath the soil, erect-ascending from a corm to ground level where they may become decumbent, ascending or remain erect, greenish and somewhat succulent above-ground, 2-18 cm long, measured from the corm to the base of the peduncle at the node of the cauline leaves; **corm** 1-4 (10) cm long and broad, spheroid to oval or pear-shaped, dark and scaly, richly white-starchy within; **roots** tough and knotted, branching profusely from the surface of the corm (chromosome numbers range from $2n = 12$ to over 190; aneuploid series are well documented within populations, and somatic numbers may vary between different tissues of the same plant).
Infraspecific Variation: A number of local and regional races are known, some of which correlate with cytological differences. The sizes of plants and their parts are quite variable, the following examples being noteworthy; a large form with leaves up to 2.5 cm broad and 15+ cm long has been called forma *robusta* (Somes) Palmer. In some plants of this type from Central New York State, the inflorescence attaches below the cauline leaf-pair, which is terminal to a short-shoot up to a centimeter long. Delicate plants with grass-like, linear leaves are also frequent from New York to the Midwest. Plants with reduced perianths and petals that are sometimes shorter than the stamens, have been called forma *micropetala* Fern. Flower color varies within and between populations, ranging from greenish-white to pure white, the petals often reddish tinged or veined, with extreme variants ranging into deep, rose-purple (rarely orange-yellow) hues.
Importance: These plants are sometimes grown from seed or brought from the wild into gardens and yards to provide ephemeral spring wildflower beds or borders. The corms were eaten by Native Americans and European settlers in eastern North America, used as a starchy food supplement. They are still eaten by wild plant enthusiasts, and are said to have a flavor similar to chestnuts or potatoes when boiled in salt water or added to stews. They are difficult to dig, however, and large populations are necessary to provide any significant nutrition. This species has proved to be of special scientific interest cytologically, due to chromosome number instability, including age-induced abnormalities (Lewis, 1970).





2. *Claytonia caroliniana* Michx.

Common Names: Spring Beauty, Carolina or White Spring Beauty, Carolina Mayflower, Wild Potato, Fairy-spuds, Tangle-gut

Type Description: Michaux, Fl. Bor. Am. vol. 1, p. 160, 1803

Synonyms: *C. latifolia* Sheldon, not Suksdorf

Origin: Native to eastern North America

Habitats: Woodland slopes clearings, mixed conifer hardwood forests, thickets and bottomlands, often in rich soils and partial shade

Habit: Perennial, ephemeral herbs with slender, decumbent to erect, semi-succulent stems arising from a corm

Flowering: Mid April-May (March further south)

Fruiting: May-June (early July)

General Distribution: Newfoundland to Saskatchewan south to Illinois, and, in the east, down the Appalachians to North Carolina and Tennessee

Description: Plants with **bisexual** flowers; **stigmas** 3, receptive at the tips and along the adaxial surfaces of short style branches; **style** 1, very slender, 1.2-3.6 mm long, with 3 recurving, stigma-bearing branches 0.7-1.2 mm long at the tip; **ovary** ovoid, ca. 1.5 mm long; **fruit** a tan, ovoid-cylindric capsule with an acute to acuminate tip, 4.0-4.5 mm long, ca. 2.5 mm broad, enclosed in a persistent calyx, dehiscing by 3 vertical sutures, and narrow inrolling valves; **seeds** (in ours) 1-2, ovoid-lenticular, 1.8-2.2 mm long and broad, the surface very lustrous, deep reddish-brown to ebony; **stamens** 5, opposite the petals; **anthers** 1.3-1.9 mm long, ca. 0.4 mm wide, pink to golden; **filaments** linear, pale, mm long, adnate to petal claws at base; **perianth** of two series; **petals** (tepals) 5, slightly clawed at base, the linear-oblong to broadly ovate or obovate limbs spreading above the calyx, (3) 5-12 mm long, 2-7 (9) mm broad, white or pink tinged, the margins entire or erose at petal tips; **sepals** 2, accrescent, 3-7 (11) mm long, 2-6 mm broad, oval, the tips obtuse to acute, glabrous, greenish, somewhat fleshy; **pedicels** glabrous, very slender, (0.2) 1-2.3 cm long, elongating during flowering, drooping or reflexing in fruit; **peduncle** erect or ascending, glabrous, 3-35 mm long, bearing a single raceme, or **inflorescence** branched into 2-4 raceme axes, up to 8 cm long with (1) 3-13 (28) flowers per plant; **bracts** present at the bases of some pedicels, the upper ones linear, minute, scarious, the lowermost lance-ovate, 1-6 mm long, 0.5-3.5 mm broad, often scarious or hyaline, sometimes totally withered by the time of fruiting; **cauline leaves** borne in a single, opposite pair, ovate to ovate-lanceolate, rhombic, broadly oblanceolate or spatulate, generally 3-5 times longer than broad, the blade 1.2-6.2 cm long (0.3) 0.5-2.5 cm broad, glabrous with a rimmed, entire margin (rarely one or more very shallow dentations), pale green, often glossy, the tip usually obtuse; **basal leaves** 0-5 (9), similar to cauline leaves but often shorter with longer petioles; **petioles** usually well differentiated, (0.1) 0.5-2.5 (3) cm long on cauline leaves, up to 7 cm on basal leaves; **stems** (1) 2-20 (30), unbranched, slender and pale beneath the soil, erect-ascending from a corm to ground level where

they may become decumbent, ascending or remain erect, greenish and somewhat succulent above-ground, 3-14 cm long (measured from the corm to the base of the peduncle at the node of the cauline leaves); **corm** 1.0-2.8 (3.5) cm long and broad, spheroid to oval or pear-shaped, dark and scaly, richly white-starchy within; **roots** tough, twisted and knotted, branching profusely from the corm surface (2n = 16, 24).

Infraspecific Variation: Plants native to northeastern North America usually bear a single seed per capsule, whereas those of other geographic regions are said in the literature to have three or more. Cauline leaves are usually petioled, but occasionally the petiole is obscure. Although sepals of this species are reported to be acute in the manuals, this is rarely the case, although the margins may be obscurely attenuate before terminating in an obtuse to blunt tip; the acute appearance is likely to be an artifact of pressing and drying specimens.

Importance: These plants may be grown from seed, and the corms are propagated easily, so they are sometimes planted in gardens for a brief show of spring color. The corms are also edible, known as a food source since pre-Columbian times. They may be boiled or added to other dishes as a supplementary starch source; they are said to have a taste similar to chestnut or potato, but their small size (mostly under 1 inch in diameter) and brief blooming period make them of minor interest as an economic food source.

Molluginaceae (Carpetweed Family)

The Molluginaceae: a family of 13 genera and 70-100 species, centered in Africa, but found in both the New World and the Asiatic tropics and subtropics. Members of the family have formerly been treated under both Aizoaceae and Caryophyllaceae.

FAMILY DESCRIPTION

Annuals or perennials with herbaceous (to woody) stems, sometimes semisucculent. The leaves are whorled (in ours), opposite, basal or alternate, simple, entire; stipules may be present or absent. The flowers are usually perfect, hypogynous, often inconspicuous, borne in panicles or cymes, terminally or in verticils at the nodes. The ovary is of 2-5 (or more) fused carpels, often incompletely multilocular toward the base, bearing numerous ovules. Stamens are 3-10, free, sometimes with a nectary ring. Sepals (4) 5, often persistent in fruit; petaloid staminodes 0-20. Petals are lacking. The fruit is a valvate capsule (loculicidal in ours) or indehiscent. The curved embryo is borne within starchy perisperm.

1. MOLLUGO

Common Names: Carpetweed, Indian Chickweed

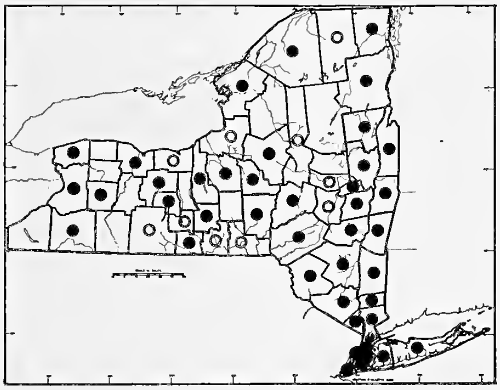
Authority: Linnaeus, Species Pl. I, p. 89, 1753

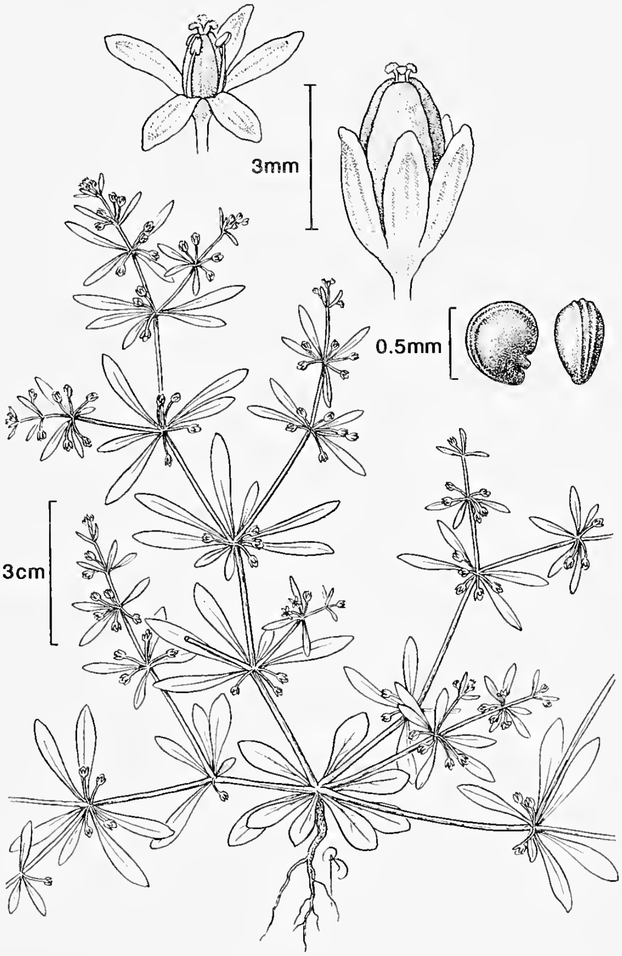
A genus of 12-15 species of the tropics and subtropics. Our common carpetweed, *Mollugo verticillata* L. has spread widely from its original natural range further south in the Americas, and another species, *M. cerviana* (L.) Sér. is a waif and rare introduction in the southern part of New York State. This species is widespread in western states, where some have suggested that it is native.

Description: Plants with **bisexual** flowers; **stigmas** 3-5; **styles** 3-5; **ovary** 1, superior, 3-5 loculed; **ovules** numerous; **fruit** a 3-5 valved, thin-walled, loculicidal capsule; **seeds** many, lacking an aril or strophiole, comma-shaped, often ribbed, with a curved **embryo** surrounded by starchy perisperm; **stamens** 3-10; **filaments** slender; **anthers** small, ovoid; **perianth** of one or two whorls; **petals** and **staminodes** absent; **sepals** 5, free, greenish to white, persistent in fruit; **pedicels** slender; **inflorescences** cymose, or flowers verticillate at the nodes; **bracts** leaf-like or absent; **leaves** whorled at the nodes; **petioles** obscure; **stipules** absent; **stems** slender, forking, creeping to erect-spreading; **root system** a taproot.

KEY TO SPECIES

1. Plants with spatulate to narrowly oblanceolate cauline leaves; flowers in verticils at the nodes and in small clusters at the leafy branch tips, lacking axillary peduncles . . . . 1. *M. verticillata*
1. Plants with linear cauline leaves, often with a conspicuous basal rosette of broader leaves; flowers borne in terminal and peduncled, axillary racemes (also in verticils at the nodes) . . . . [*M. cerviana*, a waif]





1. ***Mollugo verticillata*** **L.**
Common Names: Carpetweed, Indian Chickweed, Devil's-grip
Type Description: Linnaeus, Species Pl., p. 89, 1753
Synonym: *M. berteriana* Sér.
Origin: Native to tropical America
Habitats: A sun-loving weed of sandy roadways, fields, beaches, riverbanks and gardens
Habit: Prostrate, mat-forming annuals with branch tips sometimes ascending
Flowering: June-November
Fruiting: June-December
General Distribution: Weedy throughout temperate North America from Quebec to British Columbia and southward to Central and South America, where it is partially native as well
Description: Plants with **bisexual** flowers; **stigmas** 3, pale papillate; **styles** 3, pale, closely associated but free, flexed outward at tips; **ovary** 1, superior, ovoid, 3-carpelled, ca. 0.5 mm long; **fruit** a loculicidal capsule, ovoid, 2.3-3.4 cm long, ca. 2 mm broad, glossy greenish to tan at maturity, somewhat transparent, appearing stretched by the dark, ribbed seeds when dry, the dorsal sutures evident as grooves before dehiscence; **seeds** many, comma-shaped, lustrous golden brown with prominent, dark brown ridges mostly on the dorsal surface, aril lacking; **stamens** 3 (4), hypogynous; **anthers** golden, ovate; **filaments** slender, pale, ca. 3 mm long, running directly up the grooves of the 3 sutures of the capsule as it develops; **perianth** of a single whorl; **petals** and petaloid staminodes absent; **sepals** 5, free to base, ovoid, cucullate, (1) 1.3-2.5 mm long, upper surface glossy, whitish, the lower surface greenish, often with 3 prominent, green veins and paler margins, glabrous, tips obtuse to broadly acute; **peduncles** slender, (1) 3-9 (16) mm long, glabrous, whorled at the nodes; **inflorescence** diffuse, consisting of terminal racemes, usually of 3-10 flowers, and axillary clusters of 2-5 (8) flowers borne with the leaf whorls at the nodes; **bracts** usually found in the terminal inflorescences only, greenish, linear, 0.3-1.6 mm long; **leaves** obovate to spatulate, oblanceolate (to nearly linear in some individuals), whorled, commonly 3-5 per node, 0.4-3.5 (4) cm long, up to 1 cm broad; glabrous, entire, obtuse to acute (apiculate)

at tips, tapering to a poorly differentiated **petiole**; **stems** very slender, glabrous, sometimes grooved, much-forked, decumbent to procumbent, up to 40 cm long; **root system** a slender, long, annual taproot (2n = 64).
Infraspecific Variation: Leaf shape is quite variable, approaching the linear-leaved condition of *M. cerviana* in some plants. These have been called *M. verticillata* var. *linearis* Fenzl.
Importance: In sandy areas this can be a common weed of vegetable gardens and horticultural plantings. Carpetweed has been used as a pot herb, but its small size and stringy texture make it generally undesirable.

Caryophyllaceae (Pink Family)

The Caryophyllaceae: a family of some 80 genera and over 2,000 species worldwide, with about 60 species native or naturalized in New York State. The group has been subject to many interpretations historically, being variously subdivided into Illecebraceae, Alsinaceae, Corrigiolaceae, etc. Palynological evidence has also been offered in support of segregating the Paronychioideae as a separate family. Current morphological and chemical evidence, however, stands in favor of the recognition of a single, large family of anthocyanin-producing plants with free-central placentation and distinctive plastid ultrastructure. This concept may be revised with the advent of further studies *Paronychia* and related genera. Members of Caryophyllaceae are segregated from the Molluginaceae, thought to be more closely allied with the Aizoaceae. The center of diversity for the Caryophyllaceae is in the Mediterranean Region, but caryophylls have adapted to a broad variety of habitats around the world, often in sunny habitats, ranging from arctic-alpine to desert and Austral-montane regions. Many species are weedy adventives within and outside their native lands, and a few are noxious crop-followers. Some caryophylls are cooked as pot-greens, especially in Eurasia, while others have been used in folk medicine. Several genera are widely cultivated for their floral beauty or usefulness as accents in flower arrangements. Some of the more popular of these in horticulture are: *Dianthus* (*Caryophyllus*), the carnations, sweet-williams and bachelor's buttons, *Gypsophila*, baby's-breath, *Cerastium*, snow-in-summer, and showy-flowered *Lychnis* species such as the Maltese-cross.

FAMILY DESCRIPTION

Annual, winter-annual, biennial or perennial herbs (sometimes woody; rarely shrubby) with unilacunar, often swollen, nodes. The simple, decussate, opposite or fascicled leaves (rarely alternate) are often narrow and entire, lacking petioles; leaf bases are connate, usually clasping the node and connected by a nodal line; stipules are absent in most genera, but these may be present as unfused appendages or even form a tubular sheath. Flowers are borne in a variety of mostly dichasial inflorescence configurations (occasionally singly), including panicles, spikes and cymes. The perianth is of two distinct series (or petals may be lacking/caducous), with parts in 4s, 5s or their multiples. The calyx may be chorisepalous or gamosepalous forming a tube that is accrescent and encloses the ripening fruit (inflated in some genera). In some genera there is an epicalyx of whorled bracts subtending the flower. The corolla is actinomorphic and choripetalous, although it may simulate a salverform condition when petal limbs diverge abruptly from claws tightly invested by the mouth of the calyx tube. Petals are clawed in some genera; the claw sometimes bears lateral auricles and/or petaloid to tubular appendages (coronal scales) at the apex of the claw, where it joins with the petal limb. Petal limbs may be entire, erose, dentate, emarginate, shallowly cleft, or deeply bifid, making the petal number appear double in some species. Stamens are (1-4) 5 or (8) 10, in one or two series (or lacking in female flowers of dioecious species), the filaments free or adnate to either petals, an androgynophore or a nectary disk. The dorsifixed anthers open by longitudinal slits. Flowers are usually bisexual, but certain species are characteristically dioecious. The gynoecium is of a single, superior ovary (perigynous in *Scleranthus*) of (1) 2-5 carpels, sometimes partially or wholly septate, but usually with free-central placentation. The ovary may be borne on a ± conspicuous androgynophore or sessile. Ovules are borne variously (even singly), usually numerous, campylotropus with perisperm or nuclear endosperm. The styles are often free, numbering as many as the carpels or fewer, or there may be a basal fusion. The fruit is usually a capsule that dehisces by as many valves (or twice as many valves or teeth) as the styles; it is rarely a circumscissile capsule or a utricle. The fruit may be borne on a carpophore or not. Seeds are usually small, often ornamented and borne in large numbers.

The dicotyledonous embryo is weakly to strongly curved (almost straight in *Dianthus*), sometimes forming a ring around the starchy perisperm.

Note: The generic key requires both flowers and mature fruit, but most caryophylls set fruit quickly and continue to bear both flowers and capsules through a significant part of the growing season.

KEY TO GENERA

1. Stipules present, conspicuous to minute, but distinct from the sheathing leaf bases (or petioles) .... (2)
1. Stipules absent .... (4)
  2. Fruit a dehiscent capsule with several to many seeds; styles 3-5 .... (3)
  2. Fruit indehiscent, 1-seeded; styles 2 .... 1. *Paronychia*
3. Styles 3; stipules united into a shallow, tubular sheath at the node .... 2. *Spergularia*
3. Styles 5; stipules free .... 3. *Spergula*
  4. Fruit indehiscent, 1-seeded; calyx lobes borne on the rim of a small, leathery perigynous cup that fuses with the ovary and persists in fruit like an exocarp .... 4. *Scleranthus*
  4. Fruit a dehiscent capsule with several to many seeds; calyx hypogenous, not becoming fused with the fruit wall .... (5)
5. Stamens and petals attached to a conspicuous, lobed disk in the mouth of the flower; plants with broad, leathery, succulent leaves (sea beach habitats) .... 5. *Honckenya*
5. Stamens and petals not attached to a conspicuous disk; plants without, broad, leathery, strongly succulent leaves .... (6)
  6. Sepals fused, at least near their bases, into a distinct tube or cup; petal tips expanded into limbs from narrower basal claws; capsule often borne on a stipe (carpophore) .... (17)
  6. Sepals free or minutely fused at base, but not forming a cup or tube; petals not noticeably clawed or constricted below; capsule never borne on a carpophore .... (7)
7. Flowers (fruits) borne in a terminal umbel on a long, naked peduncle .... 6. *Holosteum*
7. Flowers (fruits) borne in cymes, panicles, corymbs, spikes or singly, but not in a long-peduncled umbel(8)
  8. Petals absent .... (14)
  8. Petals present .... (9)
9. Petals deeply 2-lobed or cleft 3/8-7/8 their length .... (15)
9. Petal tips rounded, emarginate or very shallowly cleft .... (10)
  10. Capsule valves shallowly to very deeply cleft into teeth; teeth more numerous than styles, often twice as many .... (12)
  10. Capsule valves uncleft upon dehiscence, thus, the lobes as many as the styles .... (11)
11. Styles 5 (rarely 4); petals inconspicuous, barely longer than the sepals .... 7. *Sagina*
11. Styles 3 (rarely 4); petals well-developed, significantly surpassing the sepals .... 8. *Minuartia*
  12. Capsule dehiscing by 10 short teeth surrounding a terminal pore .... 9. *Cerastium*
  12. Capsule dehiscing by 6 valves or teeth .... (13)
13. Sepals obtuse to acute, shorter than the petals; seeds often with a pale, spongy strophiole; perennial plants from delicate rhizomes .... 10. *Moehringia*
13. Sepals acuminate, longer than the petals; seeds totally lacking spongy strophioles; annuals with slender taproots .... 11. *Arenaria*
  14. Capsule valves 5, blunt or round-tipped, not even shallowly cleft; (leaves needle-like) .... 7. *Sagina*
  14. Capsule valves 5 and shallowly bifid, or deeply cleft into 6-10 teeth; (leaves various) .... (15)
15. Dehisced capsule with 5 valves, each shallowly bifid into 2 narrow teeth; styles 5 .... 12. *Myosoton*
15. Dehisced capsule with 6-10 subequal or irregular teeth (sutures between them may not always split); styles 3-5 .... (16)
  16. Capsule dehiscent by an apical or subapical aperture, ringed with 10 (rarely 8) teeth, the fruit apex often asymmetrical; styles usually 5 .... 9. *Cerastium*
  16. Capsule dehiscent to about the middle or nearly to the base by 6 valve-like teeth (rarely 8-10), the fruit apex not contorted; styles usually 3 (rarely 4-5) .... 13. *Stellaria*

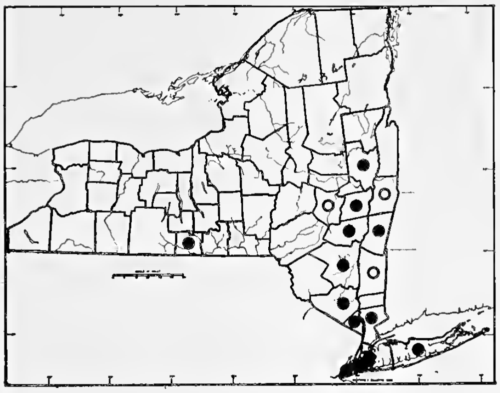
17. Calyx without basal bracts (an epicalyx); seeds plump . . . . (19)
17. Calyx with an epicalyx of 1-3 pairs of bracts immediately subtending the tube; seeds laterally compressed . . . . (18)
18. Calyx tube with 5 (to 15) veins (1-3 per lobe); commissures (veinless, scarious areas) present between the calyx veins; bracts scarious . . . . 14. *Petrorhagia*
18. Calyx tube with 30 or more veins (5 or more per lobe), lacking commissures; bracts herbaceous . . . . 15. *Dianthus*
19. Calyx lobes 2-3 cm long, lanceolate, conspicuously longer than the well-developed petals . . . . 16. *Agrostemma*
19. Calyx lobes less than 1 cm long, not greatly exceeding the petals . . . . (20)
20. Styles 2 or 2-branched (rarely a flower with 3) . . . . (21)
20. Styles regularly 3 or 5 (rarely 4) . . . . (23)
21. Flowers 4-9 (-12) mm long, borne in diffuse panicles; calyx tube 2-8 mm long, campanulate or turbinate. . . . . 17. *Gypsophila*
21. Flowers more than 12 mm long, borne in dense to open cymes; calyx tube, 12-25 mm long, cylindric to inflated . . . . (22)
22. Fruiting calyx strongly inflated with 5 prominent, ribbed angles; petals lacking appendages at the corolla throat; an annual plant from a taproot . . . . 18. *Vaccaria*
22. Fruiting calyx cylindric to somewhat ovoid, not strongly inflated or angled; petals fringed with append ages at the corolla throat; a rhizomatous perennial . . . . 19. *Saponaria*
23. Capsule dehiscing by 5 acute or bifid valves; styles equaling the capsule valves in number (5, rarely 4). . . . . 20. *Lychnis*
23. Capsule dehiscing by 6 (8 or 10) teeth; styles half the number of capsule teeth (3, 4 or 5) . . . 21. *Silene*

1. PARONYCHIA

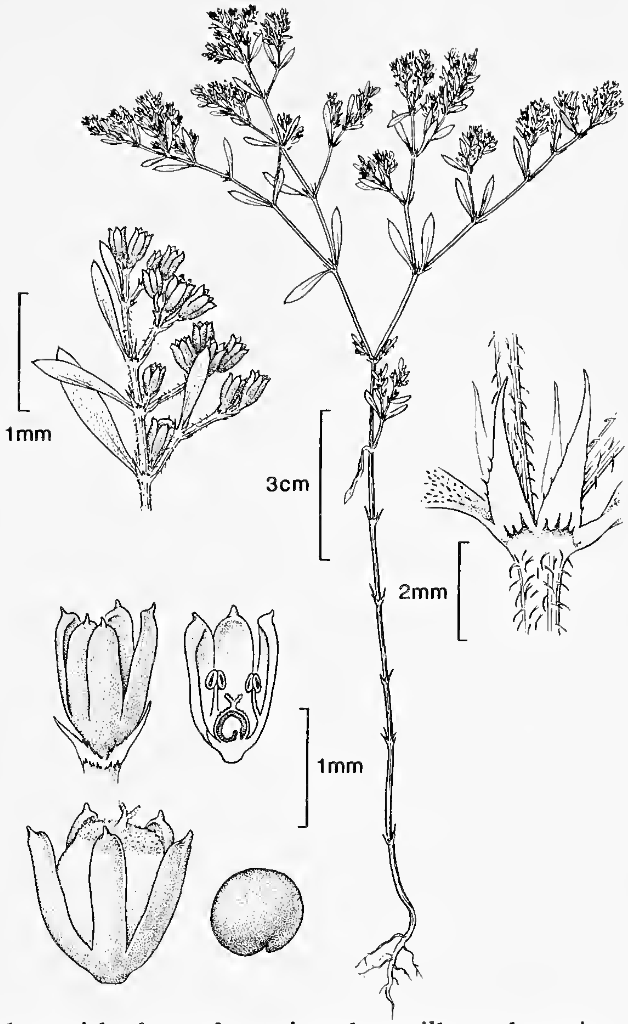
Common Names: Whitlow-wort, Silverwort
Authority: Hill, in Scott, Suppl. Chambers Cyclop. 2, 1753 (not Miller, Gard. Dict., Abr. ed., p. 4, 1754)
A genus of up to 100 or more species of mostly slender herbs, distributed widely in the warm, sandy regions of the world.
Description: Plants with **bisexual** flowers; **stigmas** 2, sessile, or bifid on a single **style**; **ovary** 1, superior or slightly adherent to the calyx tube, bearing a single fertile **ovule**; **fruit** a utricle (achene) with a tough pericarp; **seed** 1, **embryo** curved; **perisperm** present; **stamens** 2-5; **perianth** a single whorl, or the inner whorl much reduced; **petals** absent or represented by setae or minute scales; **sepals** 5, often cucullate and awned, united near the bases, investing all or most of the mature fruit; **pedicels** numerous, borne in the leaf axils; **bracts** scarious, often silvery, conspicuous and concealing the flowers; **inflorescences** dense heads to loose cymes, usually axillary; **leaves** elliptic to linear, opposite (rarely appearing alternate on the same stem); **petioles** absent; **stipules** present, usually conspicuous and scarious; **stems** capillary to wiry, often much-branched, erect or ascending (in ours); **root system** an annual taproot (in ours) or fibrous and perennial.

KEY TO SPECIES

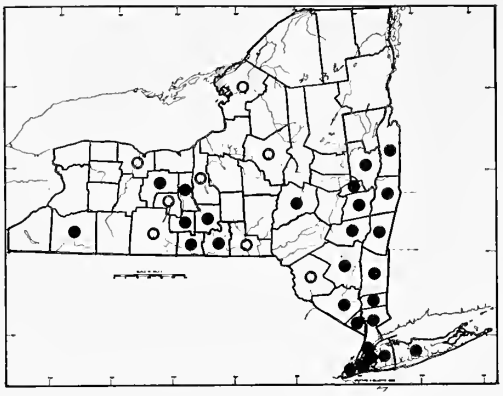
1. Stems pubescent; the upper branches often densely congested or tufted; most sepals strongly 3-ribbed, bearing a distinct mucro (awn) subterminally . . . . 1. *P. fastigiata*
1. Stems glabrous; upper branches not conspicuously congested or tufted; sepals weakly ribbed, mucros lacking or vestigial and inconspicuous . . . . 2. *P. canadensis*

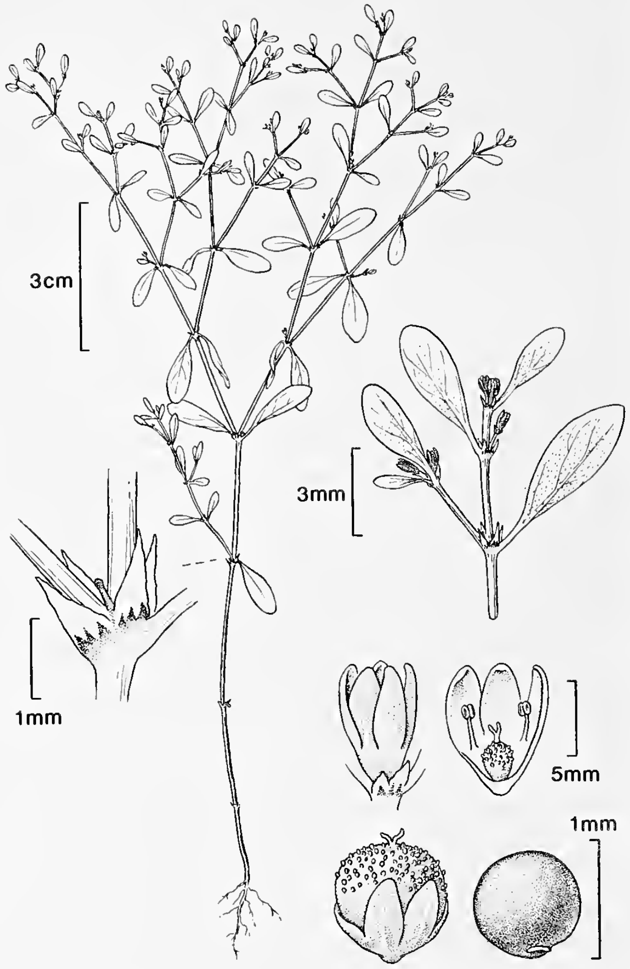


1. ***Paronychia fastigiata*** **(Raf.) Fern.**
Common Names: Forked Chickweed
Type Description: Rafinesque, Atl. Jour. 16, 1832
Synonyms: *Anychia divaricata* Raf., *A. polygonoides* Raf.
Origin: A native of eastern North America
Habitats: Dry, rocky, often shale habitats, sunny hilltops and fields, open oak woodlands, ditches, creek beds quarries and roadsides
Habit: Erect annual herbs, densely branching
Flowering: July-September
Fruiting: July-November
General Distribution: Massachusetts to Minnesota & Illinois south to Mexico, Texas and Georgia
Description: Plants with **bisexual** flowers; **stigmas** 2, minute capping the style branches; **style** bifid for about half its length, persistent in fruit, ca. 0.2 mm long; **ovary** ovoid, less than 1 mm long; **fruit** an obovoid, thin-walled utricle, 0.8-1.4 mm long and broad, brownish, the surface minutely papillose, shattering to reveal the single seed; **seed** 0.7-1.0 mm long and broad, plump, glossy brown; **stamens** 5, ca. 0.4 mm long; **anthers** globose, golden; **filaments** slender, free; **perianth** consisting of a calyx whorl and a fringe of bristles; **petals** absent, represented by a minute staminodial fringe, usually of 5 bristles; **sepals** 5 or 6, fused only at the base of the ovary, greenish to brown, persistent in fruit, partially or wholly enclosing the fruit, usually prominently 3-ribbed, 0.9-1.6 mm long, ca. 0.5 mm broad, cucullate, the adaxial surface sometimes puberulent, almost always with a distinct subterminal awn or hyaline mucro; **pedicels** absent or present, up to 0.3 mm long; **peduncles** up to 2 mm long, bracteate, sometimes with short, curved hairs; **inflorescence** diffuse, a sparsely tufted to massive fastigiate aggregate of flower clusters borne almost entirely in the crowded upper branch and leaf axils; **bracts** of the inflorescence hyaline, lanceolate with caudate tips, 0.3-1.8 mm long, subtending and sometimes exceeding the sepals in length; **leaves** opposite, narrowly elliptic to lance-obovate, much reduced and crowded on upper branches, well-developed on the main stem axis, up to 2.3 cm long, 0.6 mm broad, but usually much smaller, margins entire or with a few minute teeth and mucros at or near the acute to obtuse tips, bases tapering to a poorly defined **petiole**; **stipules** present, borne opposite the leaves, hyaline 2-3 (4) mm long, ca. 1 mm broad; **stems** much-branched above the main axis, erect-ascending with (a few) up to hundreds of spreading, branched and tufted axes, 3-35 cm tall, the crown of the herb sometimes very dense, shallowly convex or flat-topped; **root system** a slender to thick, tough, annual taproot (2n = 32, 36).



Infraspecific Variation: A number of intergrading varieties have been named, but their recognition is not recommended here. Some populations ranging from Pennsylvania southward in the Appalachians have a somewhat prostrate growth habit and short cauline leaves [var. *pumila* (Wood) Fern.]. Other taxa have been based on bract length and length of the mucro of the sepal, both of which show a great deal of variation between and within populations.





2. *Paronychia canadensis* (L.) Wood

Common Names: Forked Chickweed, Whitlow-wort, Nailwort

Type Description: Linnaeus, Species Pl. I, p. 90, 1753

Synonyms: *Achyranthes dichotoma* L., *Anychia canadensis* (L.) BSP., *A. dichotoma* Michx., not (L.), *P. dichotoma* (Michx.) A. Nels, *Queria canadensis* L.

Origin: A native of eastern North America

Habitats: Oak woodlands, clearings and rocky slopes, cliffs, shores, and other disturbed, gravelly places

Habit: Erect, much-branched annuals

Flowering: (June) July-October

Fruiting: July-November

General Distribution: New Hampshire to Minnesota and Kansas, south to Arkansas

Description: Plants with **bisexual** flowers; **stigmas** 2, minute capping the style branches; **style** bifid for ca. 2/3 its length, or occasionally 2 separate styles, persistent in fruit, ca. 0.2 mm long; **ovary** ovoid, less than 1 mm long; **fruit** a spheroid, thin-walled utricle, 0.8-1.1 mm long and broad, glistening red-brown, the surface minutely papillose, glandular, shattering to reveal a single seed; **seed** 0.7-0.9 mm long and broad, plump, glossy brown; **stamens** 2-5, ca. 0.4 mm long; **anthers** globose, golden; **filaments** free; **perianth** 1-2 whorls with true petals lacking; **petals** absent or represented by a minute staminodial fringe of 3-5 flattened bristles; **sepals** 5 (6), fused into a shallow cup at base, greenish to brown or hyaline-margined, persistent in fruit, partially enclosing, but usually not exceeding the fruit, flat to prominently cucullate (never strongly 3-veined), 0.5-0.9 mm long, ca. 0.3 mm broad, the adaxial surface glabrous, glandular-punctate, sometimes with a subterminal bulge, but lacking a distinct mucro; **pedicels** present or absent, up to 2 mm long; **peduncles** 3-8 (12) mm long, usually glabrous; **inflorescence** diffuse, the small flower clusters borne mostly in the upper branch and leaf axils; **bracts** of the inflorescence hyaline, lanceolate with acute to caudate tips, 0.3-0.6 mm long, subtending the sepals; **leaves** opposite (occasionally alternate or one leaf of the pair reduced), glandular, particularly beneath, lance-elliptic to obovate, much reduced in size on upper branches, well-developed on the main stem axis, up to 1.8 cm long, 0.8 mm broad, but usually less than 1 cm long, margins entire, tips acute to obtuse, sometimes with a mucro, bases tapering to a poorly defined **petioles** 1-2 (4) mm long; **stipules** present, often opposite the leaves (or several stipule-like organs borne at a node) hyaline 1-2 mm long, ca. 0.4 mm broad; **stems** slender, much-branched above, forking and spreading toward the tips, with up to hundreds of branching axes, the crown of the herb shallowly convex or flat-topped, the main axis erect-ascending, 2-30 (40) cm tall, tough, with minute, vertical, corky striations; **root system** a straight to gnarled, woody, annual taproot.

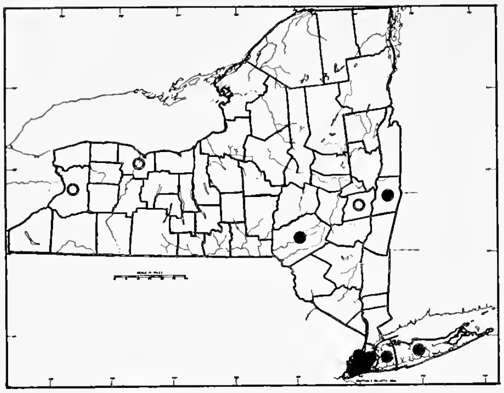
Note: Ephemeral occurrences of two species of the closely related genus, *Herniaria*, have been recorded in the vicinity of New York City: *H. cinerea* DC. was collected once near a Yonkers wool mill, and *H. glabra* L. was found once in the Bronx. *Herniaria*, a genus of up to 50 species native to the Mediterranean Region, is doubtfully taxonomically distinct from *Paronychia*. The minute flowers may be consistently 4-merous or both 4- and 5-merous on the same plant, depending upon the species. Plants of both species reported from New York State have bunchy, procumbent growth habits.

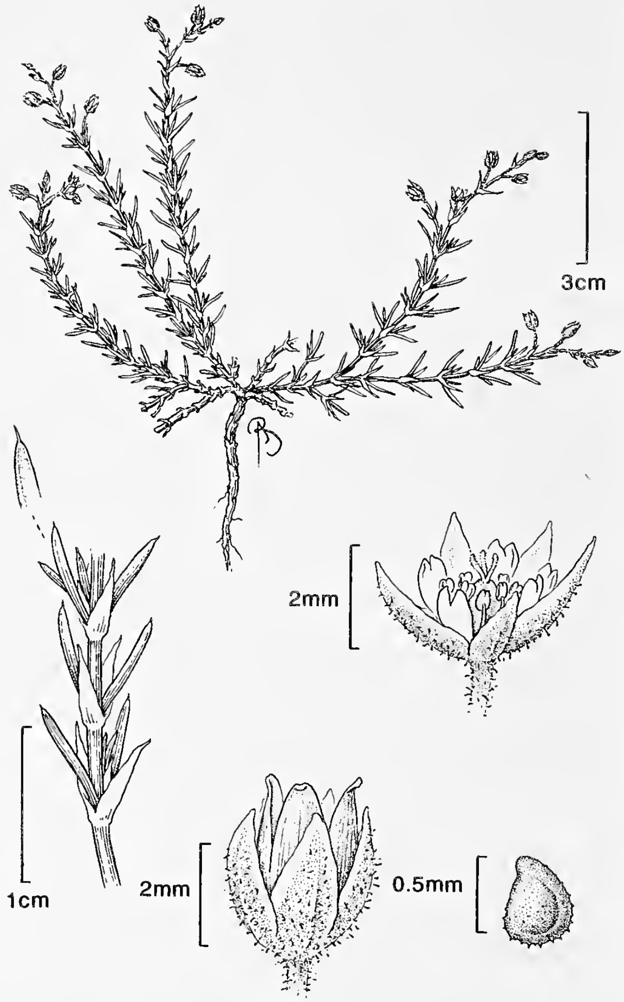
2. SPERGULARIA

Common Names: Sand-spurrey, Spurry
Authority: J. & C. Presl, Fl. Cech. 94, 1819
A genus of about 50 species, distributed around the world in maritime and inland, saline areas, mostly in Mediterranean, boreal and temperate climates.
Description: Plants with **bisexual** flowers; **stigmas** and **styles** 3 (rarely 4-5); **ovary** 1, superior; **ovules** numerous on a free central placenta; **fruit** a capsule with 3 (-5) valves; **seeds** many, sculptured or papillate, winged or unwinged; **embryo** curved, but not forming a complete ring; **stamens** (1) 2-10; **filaments** free; **anthers** globose; **perianth** of 2 distinct whorls; **petals** 5, entire; **sepals** 5, divided to near the base, persistent in fruit, partially to wholly enclosing the capsule; **pedicels** and **peduncles** slender and wiry to short and succulent; **inflorescence** loosely cymose, the flowers borne in the upper leaf and stem axils; **bracts** often leaf-like; **leaves** linear, opposite or fascicled on short-shoots, sometimes succulent; **petioles** obscure or absent; **stipules** present, scarious, united at their bases into a shallow sheath; **stems** wiry to semi-succulent, often much-branched, erect or widely spreading from a central annual stem axis or short, perennial caudex; **roots** ranging from annual taproots to woody, perennial stocks.

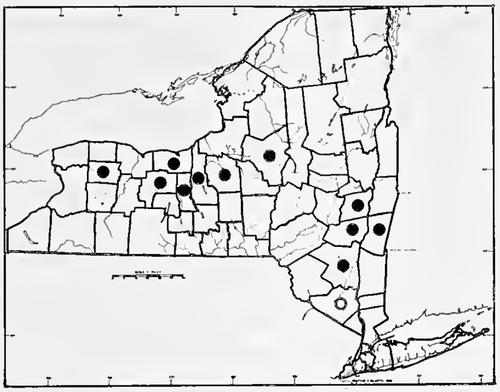
KEY TO SPECIES

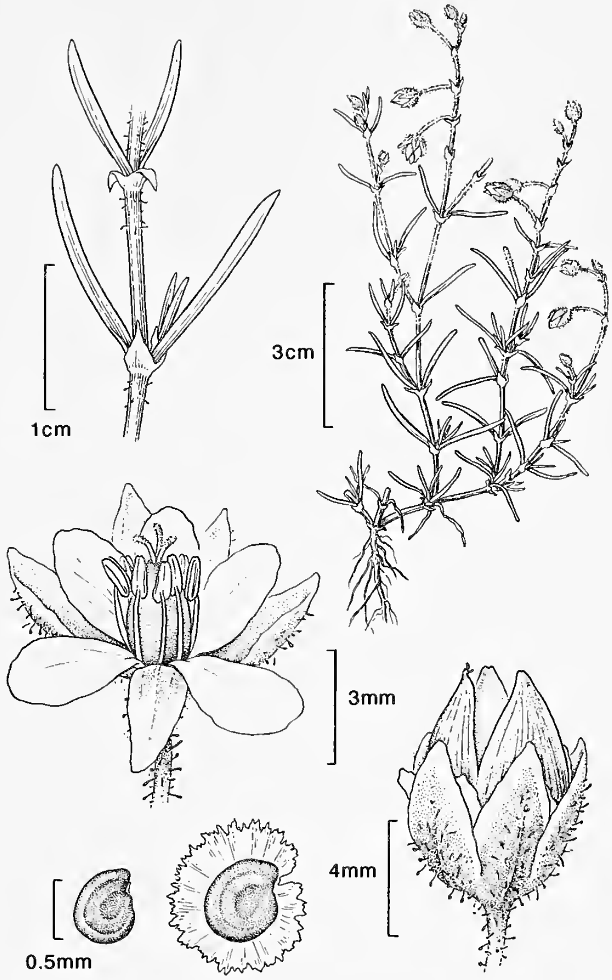
1. Most leaves with strongly mucronate or aristate tips; very short shoots with tufted leaves borne at many nodes; stipules lanceolate (to narrowly triangular); seeds 0.4-0.6 mm long, never winged, the surfaces tuberculate, not merely minutely papillate . . . . 1. *S. rubra*
1. Most leaves short-mucronate or blunt-tipped, not strongly tufted at the nodes; stipules triangular to deltoid or broadly obtuse; seeds winged or unwinged, (0.6) 0.7-1.4 mm broad, the surfaces not tuberculate (sometimes with stalked or minute papillae) . . . . (2)
  2. Stamens 8-10 (rarely 6); capsules mostly 6-8 mm long at maturity; (plants occurring mostly inland near salt mines and on salted roadsides in New York) . . . . 2. *S. media*
  2. Stamens 2-5; capsules mostly 3-5 mm long; (plants found mostly in coastal salt marshes in New York, rarely inland along salted, gravelly roadways) . . . . (3)
3. Sheaths of the middle and upper nodes miter-like, the basal cup bearing pair of triangular, stipular lobes that are acute to acuminate (the tips sometimes lacerate, toothed or bifid); seeds mostly 0.6-0.8 mm long . . . . 3. *S. salina*
3. Sheaths of the middle and upper nodes cup-like, shallowly tubular, the stipular lobes short, broadly deltoid to rounded with obtuse to truncate tips (sometimes lacerate or apiculate); seeds mostly 1.0-1.2 mm long . . . . 4. *S. canadensis*





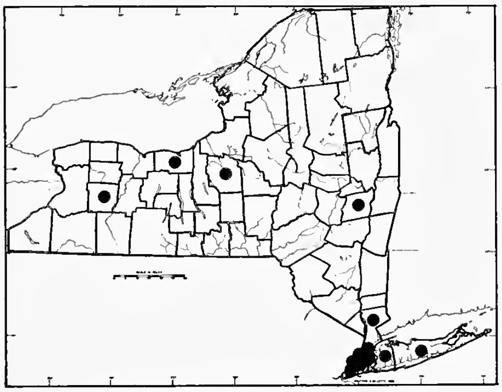
1. *Spergularia rubra* (L.) J. & C. Presl
Common Names: Common or Purple Sand-spurry, Sandwort
Type Description: Linnaeus, Species Pl. I, p. 423, 1753
Synonyms: *Alsine rubra* (L.) Crantz, *Arenaria rubra* L., *Buda rubra* (L.) Dumort., *Lepigonum rubrum* (L.) Fries., *S. campestris* (L.) Aschers., *Tissa rubra* (L.) Britt.
Origin: A native of Europe
Habitats: Dry, sandy fields, sunny waste places and cultivated ground as an introduced weed
Habit: Wiry, spreading or decumbent annuals or short-lived perennial herbs
Flowering: May-September
Fruiting: May-November
General Distribution: Newfoundland to British Columbia, south to New Jersey, with reports as far south as Virginia and Alabama (weedy in South America and in its native Europe)
Description: Plants with **bisexual** flowers; **stigmas** 3; **styles** 3, free, minute, linear, not persisting in fruit; **ovary** 1, superior ovoid to pyriform, ca. 1 mm long; **fruit** a 3-valved, smooth, tan capsule, ovoid, 3.1-4.8 mm long, 2.9-4.1 mm broad, about equaling the persistent calyx; **seeds** many, dark brown, unwinged, 0.4-0.6 mm long, comma-shaped with a dorsal ridge, the surfaces prominently tuberculate with knob-tipped protrusions; **stamens** 6-10; **anthers** golden, globose, minute; **filaments** pale, broader at base, ca. 1 mm long; **perianth** of two distinct whorls of 5; **petals** 2.2-3.4 mm long, ca. 1 mm broad, cucullate, pale to bright pink, persistent in fruit; **sepals** ovate to lanceolate, cucullate, 2.6-4.7 mm long, 1.2-3.0 mm broad, green with hyaline margins, densely glandular on the abaxial surfaces, persistent and partially enclosing the fruit; **pedicels** filiform, densely glandular, 2-10 (13) mm long; **inflorescence** diffuse, a leafy cyme with most flowers borne singly at the upper nodes; **bracts** linear, green, mucronate, glandular mostly 1-4 mm long; **leaves** 3-17 (30) mm long, linear and needle-like, not succulent, glabrous or with a few glandular hairs, paired at the nodes and commonly fascicled on axillary short-shoots giving the plants a somewhat tufted appearance; **petioles** not evident; **stipules** lustrous, whitish to silvery, scarious, linear to broadly lanceolate, sometimes lacerate or with two or more aristate tips, varying considerably in size up to 5 mm long and 2 mm broad at base; **stems** wiry, puberulent below, increasingly covered with glandular hairs upward, often much-branched, erect, ascending or decumbent, 5-20 (40) cm long, from a short caudex when perennial; **root system** a strong, sometimes woody, annual taproot or short-lived, perennial root with wiry lateral branches (2n = 18, 36, 54).
Infraspecific Variation: The plants vary mostly in stature, branching density and robustness, all of which seem to be strongly influenced by longevity of the individual.



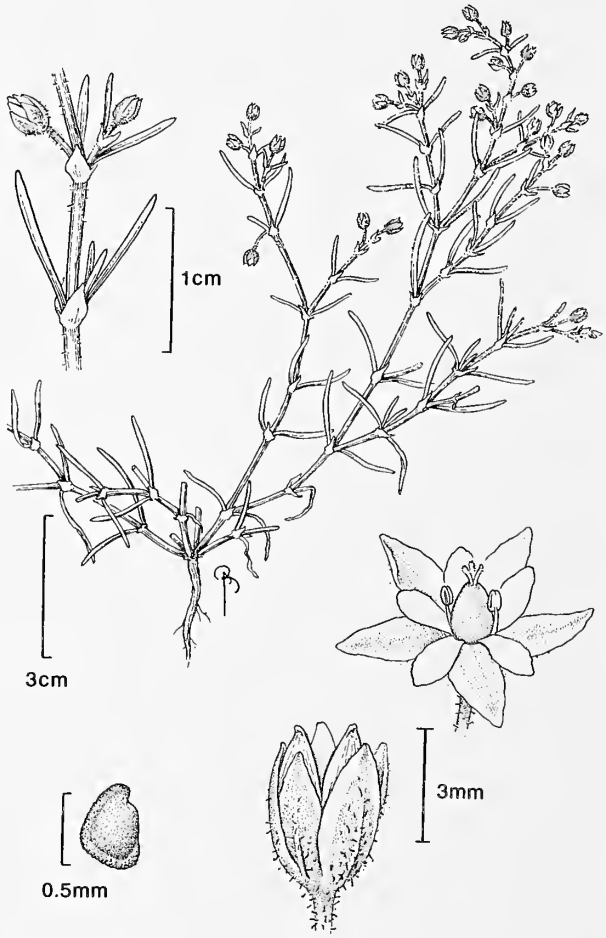


2. ***Spergularia media*** **(L.) C. Presl ex Griseb.**
Common Names: Sand-spurry
Type Description: Linnaeus, Species Pl. ed. 2, p. 606, 1762
Synonyms: *Alsine marginata* (DC. ex Lam. & DC.) Reichenb., *A. media* (L.) Druce, *Arenaria marginata* DC. ex Lam. & DC., *A. maritima* Steud., *A. media* L., *Buda media* (L.) Dumort., *Lepigonum medium* (L.) Fries., *S. alata* Wieg., *S. marginata* (DC. ex Lam. & DC.) Kittel
Origin: Native to coastal Europe
Habitats: Saline, inland sites, fields and waste places, formerly only around salt mines, but now spreading along some roadsides where highways are heavily salted in winter
Habit: Coarse, erect, spreading (rarely decumbent) biennial or perennial herbs
Flowering: June-September
Fruiting: Late June-November
General Distribution: A sporadic, European adventive of saline places: upstate New York, Pennsylvania, Ohio, Michigan, Illinois, Indiana, California and Oregon; also naturalized in Chile, Argentina and Uruguay
Description: Plants with **bisexual** flowers; **stigmas** 3; **styles** 3, minute, linear, free; **ovary** 1, superior, ovoid-cylindric, ca. 1.5 mm long; **fruit** a 3-valved, smooth, tan capsule, semi-transparent, elliptic, 5.8-9.2 mm long, 3-5 mm broad, exserted from the calyx; **seeds** many, brown, lusterless, 0.6-0.8 mm long (excluding wing), comma-shaped with a poorly defined dorsal ridge, usually alate, the wing 0.2-0.3 mm broad, completely encircling the seed, hyaline, pleated, with an entire to shallowly fimbriate margin; **stamens** (6) 8-10; **anthers** globose, golden; **filaments** pale, expanded toward the base, ca. 1 mm long; **perianth** of two distinct, free whorls of 5; **petals** white or pink with whitish margins and bases, narrowly lanceolate to lance-ovate, 2.2-4.5 mm long, 0.4-0.8 mm broad, with cucullate tips, persistent in fruit; **sepals** 3-7 (8) mm long 1-4 mm broad, narrowly to broadly ovate with acute to bluntly cucullate tips, green or pink-tinged with hyaline margins, densely hirsute-glandular on the abaxial surface or sometimes glabrous, persistent, partially enclosing the exserted fruit; **pedicels** 2-22 mm long, slender, with glandular hairs or glabrous; **inflorescence** diffuse, leafy, cyme-like, the flowers borne mostly in the upper leaf axils; **bracts** like the leaves but shorter and often sparsely to densely glandular pubescent; **leaves** 1-4 (5) cm long, linear, needle-like, the tips blunt to acute or weakly mucronate, glabrous (or with very few glandular hairs); **petioles** absent; **stipules** broadly to narrowly triangular, hyaline, glaucous, 2,3-6.2 mm long, tips acute to acuminate (rarely obtuse), sometimes toothed or bifid; **stems** 3-30 (40) cm tall, often spreading, sparsely to profusely branched from a short, tough caudex, the nodes somewhat swollen, internodes glabrous to densely glandular-pubescent in the upper nodes of the inflorescence; **root system** a tough, annual or perennial taproot with fibrous lateral branches (2n = 36).

Infraspecific Variation: Unwinged seeds are occasionally found in the same capsule with winged ones. The upper stems, pedicels and sepals are usually glandular-pubescent, but glabrous plants occur in both Europe and North America, and these tend to be diminutive in stature. Although this species is thought to be a European introduction, our plants do not conform completely with the species description in *Flora Europaea* (Monnier & Ratter *In:* Tutin *et al.*, 1964). Therefore, only those plants growing in northeastern North America are treated in the preceding description. Characteristics listed here for the American plants are largely in agreement with the treatment of Rossbach (1940). Ours have petals much like those of *S. salina* ("*S. marina*"), shorter than the sepals and sometimes pinkish rather than white. The stipules are mostly acute or acuminate, and, while the European treatment (*ibid.*) specifically states: "not acuminate," this does not hold true consistently, even for their native plants. The predominantly winged seeds, larger capsule size and greater stamen number of *S. media* are useful characters in distinguishing it from *S. salina* in North America, if not elsewhere; further comparison of the taxa worldwide would almost certainly be enlightening.



3. *Spergularia salina* J. & C. Presl
Common Names: Saltmarsh Sand-spurry
Type Description: J. & C. Presl, Fl. Cech., p. 95, 1819
Synonyms: *Alsine maritima* Pall., *Arenaria rubra* β *marina* L., *A. marina* Allioni, *Buda marina* (L.) Dumort., *Lepigonum caninum* Leffler, *L. marinum* (L.) Kindb., *Spergula salina* (J. & C. Presl) Dietr., *Spergularia canina* (Leffler) Leffler, *S. leiosperma* (Kindb.) F. Schmidt, *S. marina* (L.) Griseb., *S. tenue* Greene, *Tissa marina* (L.) Britt.
Note: This species appears in most North American literature as *S. marina* (L.) Griseb., a name based on a transfer of the infraspecific taxon, β *marina* L. I have chosen to recognize the first-published epithet at the species level.
Origin: Native to coastal Europe
Habitats: Saline, mostly coastal habitats often along shores, beach margins, and in salt marshes, with a dwarf race that rarely spreads inland along gravelly, salted roadways.
Habit: Spreading annual herbs with taproots
Flowering: Late May-October
Fruiting: June-November

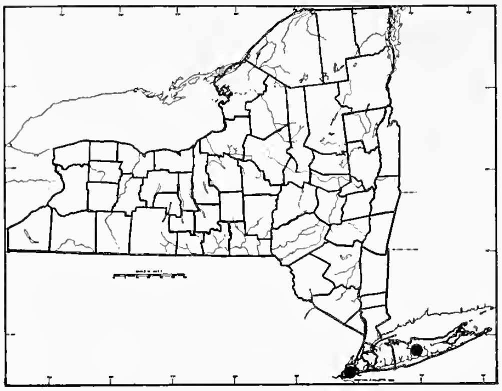


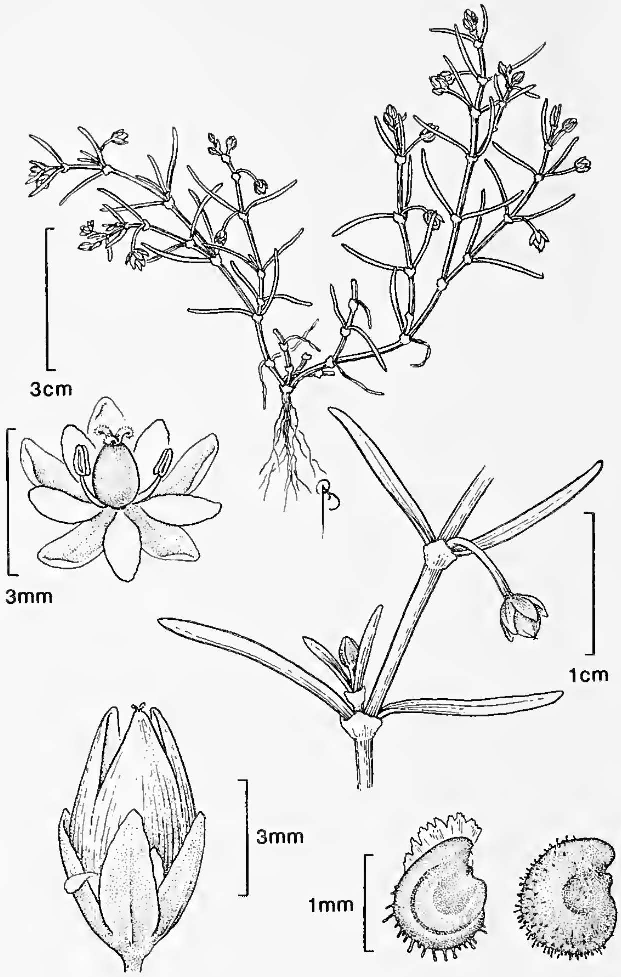
General Distribution: Introduced throughout much of North America in saline coastal areas, widely scattered inland in waste and alkaline places, Quebec to British Columbia south to Mexico and the Caribbean Islands (also Brazil and Uruguay)

Description: Plants with **bisexual** flowers; **stigmas** 3; **styles** 3, minute, linear, free; **ovary** 1, superior, cylindric-ovoid, ca. 1 mm long; **fruit** a 3-valved, smooth, pale tan capsule, elliptic to ovoid, (2) 3-5 (6.4) mm long, 1.8-4.2 mm broad, exserted from the calyx 1-2 mm; **seeds** many, medium to dark reddish-brown, smooth or with stalked papillae, most often along the dorsal ridge, 0.6-0.8 mm long (excluding wing), comma-shaped, usually not alate, the wings (when present) 0.1-0.2 mm broad, hyaline, pleated, with an entire to shallowly fimbriate margin, friable (sometimes reduced to a partial wing or a few rib-like fragments); **stamens** (1) 2-3 (-5); **anthers** globose, golden; **filaments** pale, expanded toward the base, ca. 0.8 mm long; **perianth** of two distinct, free whorls of 5; **petals** totally pink or with whitish margins and bases, narrowly lanceolate to lance-ovate, (1) 1.4-3.8 (4.1) mm long, 0.2-0.8 (1.1) mm broad, with blunt to acute tips, persistent in fruit; **sepals** 1.8-3.8 (4.2) mm long, 1-3 mm broad, narrowly to broadly ovate with acute to blunt-cucullate tips, green or pink-tinged with hyaline margins, densely hirsute-glandular on the abaxial surfaces, or sometimes glabrous, persistent, partially enclosing the exserted fruit; **pedicels** 1-23 mm long, slender, covered with glandular hairs (rarely glabrous); **inflorescence** diffuse, leafy, cyme-like, the flowers borne mostly in the upper leaf axils; **bracts** like the leaves but shorter and often sparsely to densely glandular pubescent; **leaves** (0.3) 1-3 (4) cm long, linear, needle-like, the tips blunt to acute or very weakly mucronate, glandular-pubescent or glabrous; **petioles** absent; **stipules** triangular to broadly deltoid, hyaline, whitish, 2,3-6.2 mm long, tips acute to acuminate (rarely obtuse), sometimes toothed or bifid; **stems** 1-25 (34) cm tall, often spreading, sparsely to profusely branched, the nodes somewhat swollen, internodes glabrous to densely glandular-pubescent in the upper nodes of the inflorescence; **root system** an annual taproot ($2n = 36$).

Infraspecific Variation: The seeds of *S. salina* may be wholly or partially winged or wingless, with smooth or papillate surfaces. In Europe unwinged seeds have been attributed partially to adaptation of populations to disturbed habitats (Sterk, 1969d), but wing variations may vary greatly between the seeds produced within a single capsule. *Spergularia tenue* Greene is based on California plants distinguished morphologically by their much-branched inflorescences with very small sepals, petals and capsules. They are said to occur with populations of more typical plants of the species, but to flower and fruit earlier. Rossbach (1940) treated this group as *S. marina* var. *tenue* (Greene) Rossbach. Diminutive plants recently found in New York State are possibly referable to this taxon, as discussed under the following heading.

Taxonomic Note: *Spergularia tangerina* P. Monnier, described from the Iberian Peninsula of Spain in 1964, was based on very similar characteristics to those of *S. tenue* Greene. If these taxa are determined to be equivalent, Greene's name, *S. tenue*, based on American plants, would, ironically, take precedence. Biosystematic studies by Monnier (1975b) indicated that "*S. tangerina*" is possibly ancestral to widespread *S. salina*. Thus, certain North American populations of *S. salina* may be exhibiting atavism under strong selective pressure. Plants recently found on salty roadsides in New York State and elsewhere in the northeast have similar (even smaller) flower parts than *S. tangerina*, along with very slender stems, but they lack profusely-branched inflorescences. Rare New York specimens of these tiny annuals have flowers with 2-3 stamens, petals 0.9-1.3 mm long, sepals 1.9-3.5 mm long, and a mature capsule 2.0-3.4 mm long, equaling or barely exceeding the calyx. The seeds are pale brown, unwinged and 0.5-0.8 mm long, with scattered, stalked papillae. Such plants do not match descriptions of any European taxa yet seen in the literature. In the light of studies on reduction series within *S. salina* as a whole (Sterk, 1968-1972), these variants are probably best treated as members of a diminutive race or phenotypic modification series within a single polymorphic species. Their gravelly roadside habitats are sustained by severe and continued disturbance, including summer grading and winter salting, with nutrients undoubtedly in poor supply.





4. *Spergularia canadensis* (Pers.) D. Don

Common Name: Northern Sand-spurry, Bed Sandwort

Type Description: Persoon, Syn. vol. 1, p. 504, 1805

Synonyms: *Alsine canadensis* (Pers.) House: *Arenaria canadensis* Pers., *Buda borealis* S. Wats., *Spergula canadensis* (Pers.) Dietr., *Tissa canadensis* (Pers.) Britton

Origin: A native of coastal North America

Habitats: Cold, windy coastlines in saline, often acidic, muck or sand

Habit: Decumbent, fleshy, annual herbs with slender taproots

Flowering: June-October

Fruiting: June-November

General Distribution: Mostly boreal and arctic coastlines in northeastern and northwestern North America: Newfoundland south to Connecticut (formerly New York), coastal Alaska and British Columbia south to California

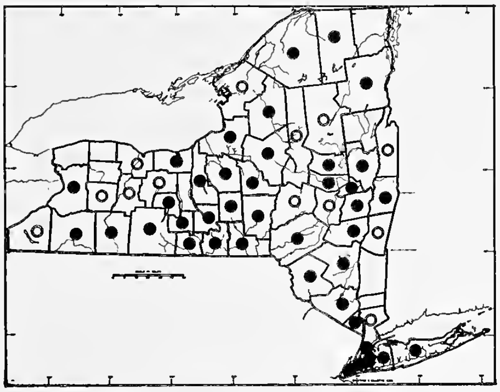
Rarity Status: Probably extirpated from the two known sites in New York State. Ranked by the New York Natural Heritage Program as G5 (globally secure), SX (State extirpated), with no current protection under State law. One site was known on Long Island and one on Staten Island (1880s).

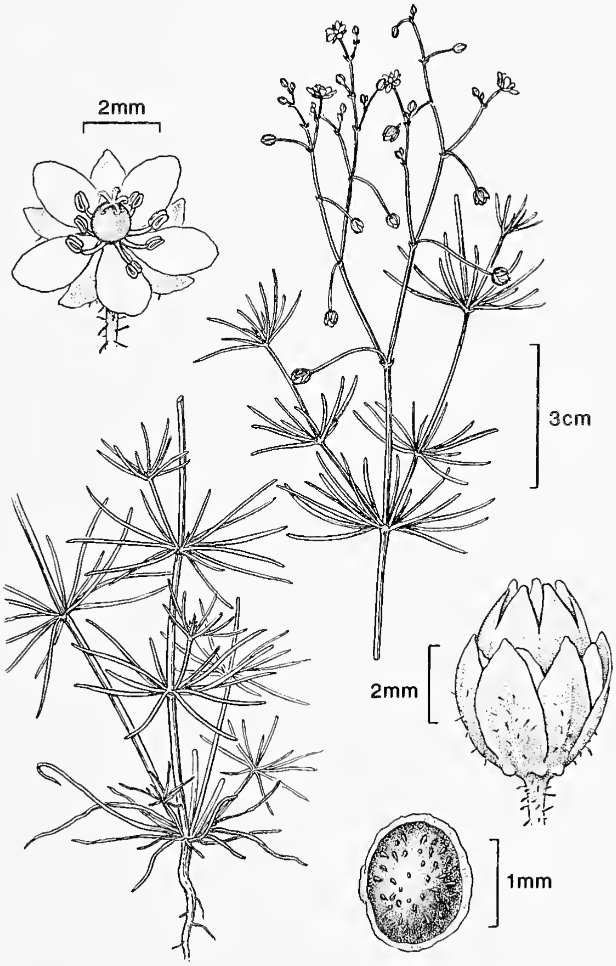
Description: Plants with **bisexual** flowers; **stigmas** 3; **styles** 3, minute, linear, free; **ovary** 1, superior, ovoid-cylindric, ca. 1.5 mm long; **fruit** a 3-valved, smooth, pale tan capsule, elliptic to ovoid, 3.3-5.4 mm long, 1.8-3.8 mm broad, exserted from the calyx up to 2.6 mm; **seeds** many, medium to dark brown, smooth, slightly crested or with stalked papillae that are most abundant along the plump, dorsal ridge, (0.8) 1.0-1.3 (1.4) mm long (excluding wing), comma-shaped, unwinged or with wings 0.1-0.3 mm broad, hyaline, pleated, with an entire to shallowly toothed or wavy margin, friable (sometimes reduced to a partial wing or a few rib-like fragments); **stamens** 2-5; **anthers** globose, golden; **filaments** pale, expanded toward the base, ca. 0.7 mm long; **perianth** of two distinct, free whorls of 5; **petals** white or pink, narrowly lanceolate to lance-ovate, (0.8) 1.4-2.6 mm long, 0.2-0.8 (1.1) mm broad, with blunt to acute tips, persistent in fruit; **sepals** 1.8-3.2 mm long, 1-2 mm broad, narrowly to broadly ovate with acute to blunt, cucullate tips, green or pink-tinged with hyaline margins, glabrous, persistent, only partially enclosing the strongly exserted fruit; **pedicels** 4-16 mm long, often reflexed in fruit, glabrous (rarely sparsely glandular); **inflorescence** diffuse to dense, leafy, cyme-like, the flowers borne mostly in upper leaf axils; **bracts** like the leaves but shorter; **leaves** 0.6-4.7 cm long, linear, fleshy, glabrous, the tips blunt; **petioles** absent; **stipules** broadly deltoid to obtusely rounded or almost completely fused, comprising only the cup of the sheath, hyaline, less than 1 mm long, tips very obtusely pointed or rounded, (sometimes apiculate, bifid or with tiny teeth); **stems** decumbent, 2-35 cm long, sparsely to profusely branched, the nodes somewhat swollen, internodes glabrous; **root system** an annual taproot (2n = 36).

Infraspecific Variation: Variety *occidentalis* Rossbach, ranges from California to British Columbia; it differs from the typical variety in having a more ascending habit, larger stipules, a less exserted capsule and some glandular pubescence.

3. SPERGULA

Common Name: Spurrey
Authority: Linnaeus, Species Pl., p. 440, 1753
A genus of about 5 species, native to the Old World. *Spergula arvensis* L. is an aggressive weed of cultivated fields that has become a common naturalized weed in New York State and around the world. Two other spurreys, *S. pentandra* L. and *S. morrisonii* Bor., are naturalized in eastern North America as far north as southern New Jersey.





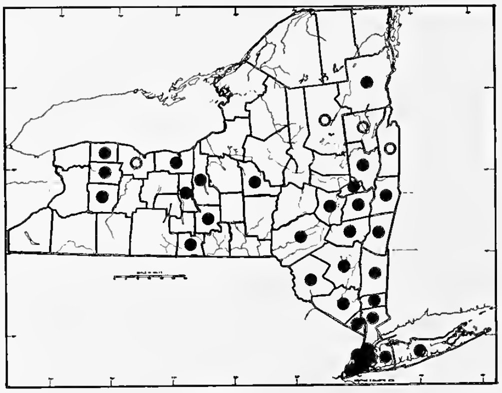
1. *Spergula arvensis* L.
Common Names: Corn-spurry or Spurrey, Poverty-weed, Pine-cheat, Cow-quake, Pick-purse, Yarr
Type Description: Linnaeus, Species Pl. I, p. 440, 1753
Synonyms: *S. arvensis* var. *sativa* (Bönn.) Mert. & Koch, not Reichenb., *S. linicola* Boreau, *S. maxima* Weihe, *S. sativa* Bönn., *S. vulgaris* Bönn.
Origin: A native of Europe
Habitats: Sandy and gravelly soils, especially as a weed of cultivated ground, waste places, roadsides and railroad tracks
Habit: Slender, ascending annuals from taproots
Flowering: June-September
Fruiting: June-November
General Distribution: Native to Europe, a weed in North America from Newfoundland to Alaska, south to California, Louisiana and Florida
Description: Plants with **bisexual** flowers; **stigmas** 5, papillate; **styles** 5, minute, free to near the base, persistent until dehiscence; **ovary** ovoid, ca. 1 mm long; **fruit** a 5-valved capsule, 3.8-5.4 mm long, 3.5-4.4 mm broad, spheroid to elliptic or ovoid, only slightly exserted from the perianth, glossy tan, the valves opposite the sepals; **seeds** several to many, frequently polyembryonic, 0.9-1.6 mm broad, ca. 0.7 mm broad, lenticular, with a very narrow, circumferential, pale tan wing, seed surface dull, rough, dark brown to ebony, often with scattered, pale, glandular papillae; **stamens** 5-10; **anthers** minute, golden; **filaments** pale, 1-2 mm long; **perianth** of 2 distinct whorls; **petals** 5, free, white, narrowly to broadly ovate, 1.5-3.6 (5) mm long, 1-3 mm broad, with acute to obtuse tips, persistent; **sepals** 5, free, ovoid, 2.6-4.6 (5.2) mm long, 2-3 mm broad, with acute to obtuse tips,

green with narrow hyaline margins, sparsely to copiously glandular-pubescent on the adaxial surfaces, persistent, almost completely enclosing the capsule at maturity; **pedicels** slender, mostly 1.0-2.5 cm long, glandular pubescent to glabrescent, often reflexed in fruit; **peduncles** much like the pedicels; **inflorescence** a diffuse, often dichotomously branched, panicle, terminal, or with a few small axillary branches, totaling up to 1/2 the plants height; **bracts** scarious, lance-ovate to cordate with acute tips, ca. 1 mm long; **leaves** whorled, appearing fascicled or tufted on the short shoots at the nodes, linear, the lower ones grooved near the base, 1-5 (6) cm long, 0.5-1.3 mm broad, sometimes viscid-glandular, usually glabrous, dull to bright green; **petioles** absent; **stipules** ovate-cordate to triangular-acute, 1-2 mm long, hyaline; **stems** simple to much-branched, erect-ascending, slender, grooved, glabrescent to moderately glandular-pubescent, 5-45 (70) cm tall; **root system** a slender to relatively stout, annual taproot with bunchy lateral branches [2n = 18 (36)].
Infraspecific Variation: Plants sometimes segregated as *S. arvensis* var. *sativa* (Bönn.) Reichenb. are descended from escaped cultivars. They are dull green and viscid and lack glandular papillae on the seeds. Characters once considered to be of taxonomic significance, such as stem pubescence and seed coat papillae have been shown to vary clinally (New, 1958).
Importance: These plants get the name corn-spurry from their aggressive, weedy invasion of grain fields, in this case referring to wheat, the "corn" of pre-Columbian Europe. Although the plants contain bitter and poisonous saponins, they have been grown successfully for centuries as fodder for farm animals. An 18th century report claims that spurry was eaten by humans in times of famine in northern Europe, dried, ground and baked into wheat bread in small quantities as an adulterant.
Note: *Spergula morrisonii* Boreau was reported once as a waif in the vicinity of Rochester early in the 20th century.

4. SCLERANTHUS

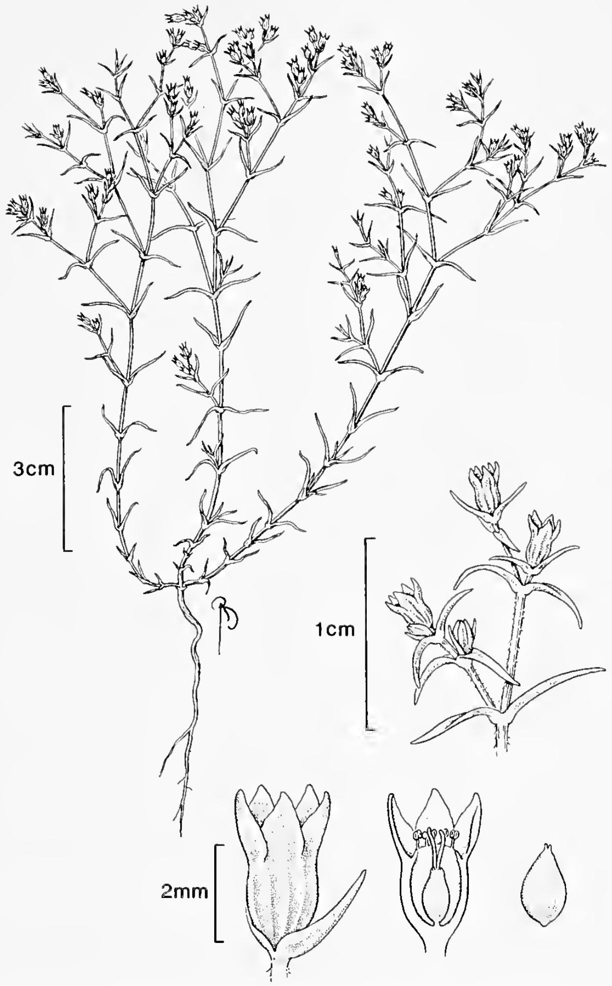
Common Names: Knawel, German Knotgrass
Authority: Linnaeus, Species Pl. I, p. 406, 1753
A genus of 3-12 species, depending on the degree of taxonomic splitting employed when treating the *S. perennis* and *S. annuus* complexes. The plants are native to Eurasia and are commonly weedy in temperate climates around the world.

1. *Scleranthus annuus* L.
Common Names: Knawel, German Knotgrass, Parsley-piert, Gravel Chickweed,
Type Description: Linnaeus, Species Pl. I, p. 406, 1753
Origin: A native of Europe
Synonyms: *S. annuus* ssp. *ruscinonensis* (Gillot & Coste) P. Sell, *S. uncinatus* Schur
Habitats: Open areas, gravelly roadsides, paths, railways, and also more natural areas such as limy forest clearings and sand plains
Habit: Spreading, with tufted, much-forked stems; annuals from taproots
Flowering: (March) May-October
Fruiting: May-December
General Distribution: Northern Newfoundland to Minnesota, south to Indiana and along the Coastal Plain to Florida
Flowering: (March) May-October
Fruiting: May-December



General Distribution: Northern Newfoundland to Minnesota, south to Indiana and along the Coastal Plain to Florida

Description: Plants with **bisexual** flowers; **stigmas** 2, terminal, papillose; **styles** 2, filiform, 0.7-0.9 mm long, hyaline; **ovary** 1, bearing a single **ovule** on a basal placenta (rarely 2), the ovary partially inferior, fused to a hypanthium; **fruit** 1.2-1.7 mm long, ca. 1.3 mm broad, a utricle (nut), remaining within the persistent hypanthium, bearing 1 (rarely 2) seeds; **seed** 1 (very rarely 2), spheroid to lenticular, beaked, tan, ca. 0.8 mm long; **stamens** 4-10, minute, adnate to a ring-like septum at the junction of the fruit and hypanthium; **anthers** globose, golden; **filaments** linear, straight or inwardly curved; **perianth** a perigynous cup, fused to the gynoecium for 2/3 or more of its length, bearing a whorl of free perianth lobes; **petals** absent; **sepals** (perianth lobes) 5, perigynous, 1.0-2.3 (3) mm long, 0.3-0.9 mm broad at base, lanceolate with acute often abruptly cucullate tips, green with very narrow (ca. 0.1 mm) scarious margins, mostly glabrous, but with a few septate hairs at the hypanthial base; **pedicels** very short, often less than 1 mm, ensheathed in the base of a floral bract, or flowers sessile; **peduncles** up to 1.5 cm long, pilose, with septate hairs that are somewhat retrorse and borne mostly along one side of the peduncle; **inflorescence** diffuse throughout the plant, with axillary and terminal clusters of 2-4 flowers; **inflorescence bracts** much like the leaves, often exceeding the flowers, even in the short-bracted, terminal clusters; **leaves** opposite, linear, 3-8 (13) mm long, groovy, green, acute to obtuse tipped, the margins gradually broader, scarious and ciliate toward the base where they are flared and connate, clasping the nodes; **petioles** and **stipules** absent; **stems** terete, glabrescent to densely retrorse-pilose, branched from near the base, ascending, 2-12 (26) cm long; **root system** an annual (biennial) taproot with matted lateral roots (2n = 22, 44).



Infraspecific Variation: Our plants are do not conform well with any described European subspecies. They have very small fruits like ssp. *ruscinonensis* (Gillot & Coste) P. Sell, but the sepals are usually spreading and only occasionally connivent, as in the typical subspecies. In many flowers of some individuals, the boat-like (cucullate) apices of the sepal tips are curved abruptly inward and hook-like, the only character used to distinguish *S. uncinatus* Schur in Europe. In North America, the plants seem to comprise a single, slightly polymorphic species lacking in consistent characters useful in segregating taxa, even at the infraspecific level.

Importance: A weed of grain fields, particularly wheat, oats and barley; probably introduced a number of times through European seed sources.

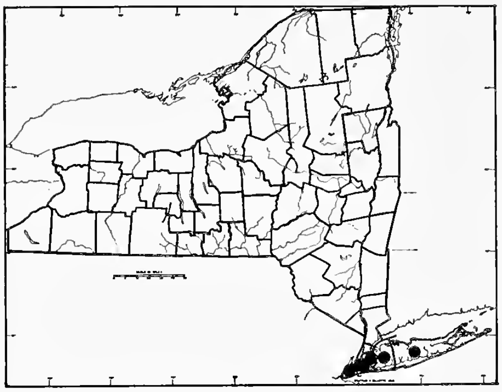
5. HONCKENYA[1]

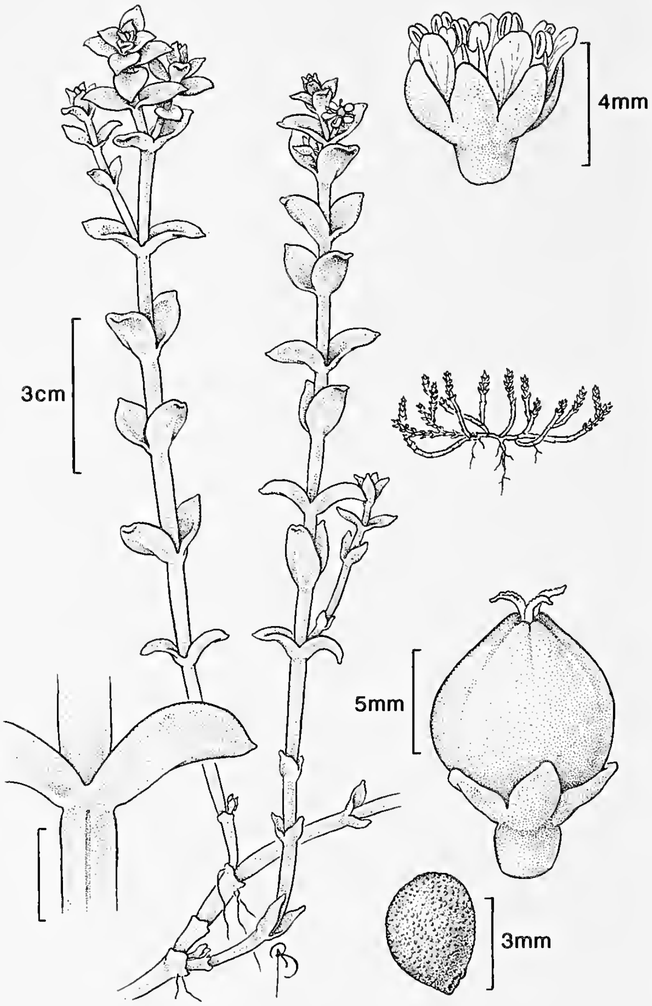
Common Name: Seabeach Sandwort

Authority: Ehrhart, Neues Mag. Aerzte 5, p. 193, 1783

[1]**Note:** The common use of a spelling variation, *Honkenya*, in the literature was based on Ehrh., Beitr. vol. 2 (1788), incorrectly assumed to be the earliest citation for the generic name.

A single, polymorphic species, historically included in *Arenaria*. *Honckenya* is a conspicuous, succulent, seaside plant, mostly of boreal and arctic shores, with a range that encircles the Northern Hemisphere.





1. *Honckenya peploides* (L.) Ehrh.
ssp. *robusta* (Fern.) Hultén

Common Names: Seabeach Sandwort, Sea Chickweed, Sea Purslane, Beach-parsley

Type Description: Linnaeus, Species Pl., p. 423, 1753

Synonyms: *Ammodenia peploides* (L.) Rupr., *A. maritima* (Raf.) Bickn., *A. peploides* var. *maritima* (Raf.) Stone, *Arenaria peploides* L., *A. peploides* var. *robusta* Fern., (*Honkenya*)

Origin: A native of arctic seashores; ssp. *robusta* is eastern North American

Habitats: Maritime sands: dunes, beaches, saltmarshes, inlets and pond shores

Habit: Procumbent to decumbent, perennial, mat-forming herbs

Flowering: May-September

Fruiting: June-October

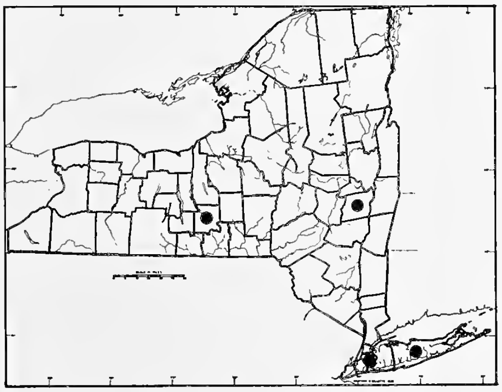
General Distribution: The species range is arctic-circumboreal; ssp. *robusta* occurs from Belle Isle, Newfoundland, southward along the Atlantic Coast to Maryland and Virginia

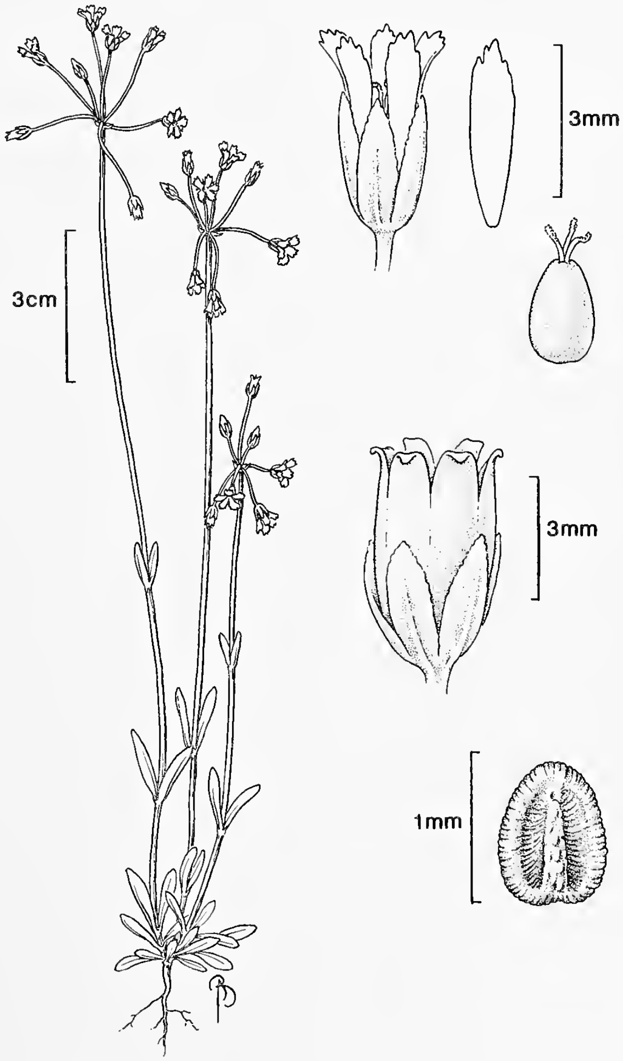
Description: Plants with **flowers** that appear perfect, but are often functionally unisexual; **stigmas** 3 (-6); **styles** 3 (-6), distinct, columnar, succulent, ca. 1 mm long, sometimes persisting in fruit; **ovary** 1, pyriform, glabrous, 3-4 mm long and equally broad at base, 3-5 bilobed, fused carpels; **fruit** a tough, leathery, brownish capsule, 5-9 mm long, (5) 5-10 (12) mm broad, subglobose to ovoid, unilocular, dehiscing by 3-5 valves; **seeds** usually 8 or fewer, 4-5 mm long, ca. 3.5 mm broad, pyriform or obovate to comma-shaped, often somewhat compressed and distorted, moderately glossy, reddish-brown with minutely muricate surfaces; **stamens** usually 10 (8-11), 3-4 mm long; **anthers** golden (brown if non-functional), ovate, ca. 1 mm broad; **filaments** fleshy, greenish, thicker toward the base, ca. 3 mm long, arching upward, with golden nectaries at their bases, where they are inserted on a fleshy disk; **perianth** of 2 distinct whorls; **petals** 5 (6), free, spatulate, 3.9-6.2 (7.2) mm long, 2.8-3.6 (4.5) mm broad above the claw, creamy to yellowish, somewhat translucent; **sepals** 5, free, tough, semisucculent 2.9-5.2 (6) mm long, ca. 3-5 mm broad, ovate to broadly lanceolate and incurved, with obtuse (to acute), strongly cucullate tips, glabrous, lustrous green with hyaline margins; **peduncles** stout, 1-3 mm long; **flowers** borne singly (rarely a pair), mostly in the axils of the upper leaves and branches; **leaves** opposite, decussate, sessile, succulent, glabrous and glossy, lustrous pale green to jade, (0.4) 0.6-3.5 (4.5) cm long, 0.3-2.7 (3.5) cm broad, entire, ovate or elliptic or oblong (to broadly lanceolate) with mucronate to apiculate tips, the bases clasping the node, often confluent with those of the leaf opposite; **petioles** and **stipules** absent; **nodes** slightly swollen, with 2 hair-line grooves extending down the **internodes** from the junctures of the opposite leaf bases; **stems** succulent, mat-forming, creeping, procumbent to suberect at tips, 10-20 (-50) cm tall, with

lateral branches near the apex, 4-8 mm broad, yellow-green to creamy, pink at the plant base and brownish when buried under sand or soil, the subterranean, much-branched **rhizomes** and drift-buried stems ascending at their tips, tough, mostly 2-6 mm broad with scale-like leaves and **adventitious roots** at the nodes; **root system** fibrous (2n = 48, 66, 68, 70).
Infraspecific Variation: Typical *H. peploides* ssp. *peploides* (of arctic-circumboreal distribution) bears its flowers in more or less distinct cymes, whereas ssp. *robusta* of our range has primarily solitary flowers. Plants of more northerly regions also have relatively flaccid stems, 1-2 mm thick, while the more southern subspecies has turgid, fleshy stems 2-6 mm thick. Another taxon, ssp. *major* (Hook.) Hultén, occurs north of our range, and is distinguished from the typical subspecies by its smooth seeds and larger, transluscent capsules.
Importance: *Honckenya* is sometimes planted in sandy gardens and propagated or encouraged along seashores, where it provides a mat-forming ground cover. The leaves and young stems are eaten raw and used in salads, to which they are said to lend a flavor similar to cabbage. In Eurasia the greens are fermented in various ways, used in pickling and made into sour sauces and relishes. In Iceland they are steeped in whey before fermentation; the resulting liquor is strained off for use as a drink or an oily salad dressing.

6. HOLOSTEUM

Common Names: Jagged Chickweed
Authority: Linnaeus, Species Pl, I, p. 88, 1753
A genus of fewer than 5 species, native to Eurasia.





1. *Holosteum umbellatum* L.
Common Names: Jagged Chickweed
Type Description: Linnaeus, Species Pl., I., p. 88, 1753
Synonyms: *H. glutinosum* (Bieb.) Fischer & Meyer, *H. umbellatum* ssp. *glutinosum* (Bieb.) Nyman
Origin: Native to Eurasia
Habitats: Sandy soils, escaped on beaches and roadsides, in lawns, fields, waste places
Habit: Erect, annual (winter annual) herbs
Flowering: (March) April-May (June)
Fruiting: April-August
General Distribution: A Eurasian adventive in North America, it occurs at scattered locations, mostly along the Coastal Plain from Massachusetts to Georgia, inland to Illinois, Nebraska and Oklahoma, and British Columbia to Oregon; it is probably not as rare in New York State as the distribution map would indicate

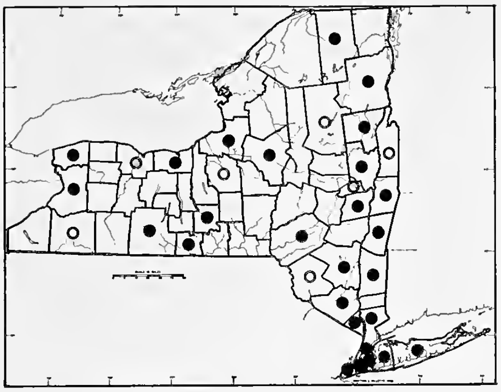
Description: Plants with **bisexual** flowers; **stigmas** 3 (4), terminal, minutely papillose, **styles** 3 (4), linear, 0.4-0.9 mm long; **ovary** 1, superior, ovate-elliptic, ca. 1 mm long; **fruit** a glossy, tan, striate, thin-walled capsule, 3.6-6.4 mm long, 2.8-3.3 mm broad, cylindric-ovoid strongly exserted from the perianth, especially after dehiscence, the 6 valves with tips reflexed outward; **seeds** many, tan to reddish-brown, asymmetrical, roughly reniform, 0.4-0.8 mm long and broad, grooved, surfaces both tuberculate and minutely papillose; **stamens** 3-5 (rarely 8-10); **anthers** reniform, golden; **filaments** linear, ca. 1 mm long; **perianth** of 2 free whorls; **petals** 1.6-4.7 mm long, 1-3 mm broad, lance-elliptic, white or pale pink, tapering to ragged or cut (entire) tips; **sepals** 1.4-3.6 mm long, elliptic-ovate, green with hyaline margins and obtuse (to acute) tips, entire, glabrous, persistent and enclosing the lower half of the capsule; **pedicels** 0.8-2.3 (3) cm long, slender, glabrous, reflexed in fruit; **peduncle** (1) 3-9 (15) cm long, solitary, terminal, glabrous to densely glandular pubescent and viscid below; **inflorescence** a simple umbel of (2) 3-12 (15+) flowers; **bracts** hyaline, clasping, obtuse, less than 1 mm long; **cauline leaves** paired, connate at base, clasping the nodes, 3-20 mm long, 2-8 mm broad, ovate-elliptic, acute, entire, the margins sometimes ciliate; **basal leaves** 5-28 mm long, 2-9 (13) mm broad, elliptic-obovate to linear-spatulate, the surfaces glabrous, somewhat glaucous, bases slightly clasping or narrowed to a poorly delineated **petiolar** zone; **stipules** absent; **stems** slender, terete, sometimes grooved, glabrous (below) to glandular-viscid above or throughout, simple to much-branched near the base, erect or ascending, up to 20 (35) cm long; **root system** a slender, annual taproot with delicate lateral branching (2n = 20).
Infraspecific Variation: In Europe, ssp. *glutinosum* is recognized on the basis of greater overall viscidity and 8-10 stamens rather than 3-5, as in typical plants.

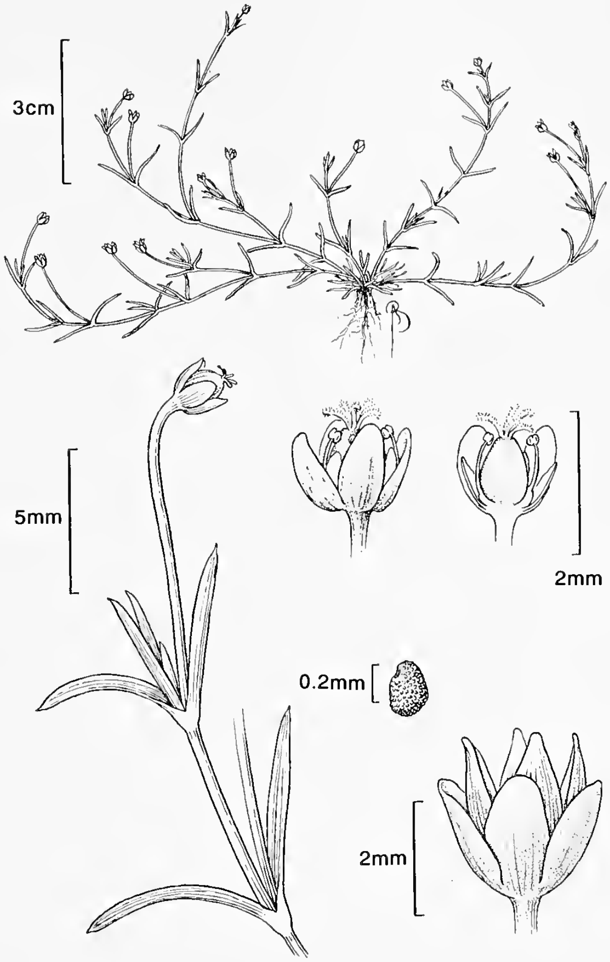
7. SAGINA

Common Names: Pearlwort
Authority: Linnaeus, Species Pl. I, p. 128, 1753
A genus of about 15 species distributed mostly in cool-temperate and boreal regions of the Northern Hemisphere. They often inhabit sunny, sandy or rocky sites, and sometimes become weedy, even within their native ranges, following human disturbance.
Description: Plants with **bisexual** flowers (rarely gynodioecious); **stigmas** 4-5, papillate along the inner surface of the styles; **styles** 4-5, alternating with the sepals, recurved at anthesis; **ovary** 1, 4-5 carpelled, often globose; **ovules** many (to 130+), campylotropous, on a free central placenta; **fruit** a 4-5 valved capsule, dehiscing near the apex or splitting to base; **seeds** many, less than 1 mm long, globose to triangular, tuberculate, papillate or smooth, sometimes ridged; **stamens** 4-10, borne in 1-2 whorls of 4 or 5, or the inner whorl missing in some species, the outer whorl with nectaries at the base; **anthers** minute, ovoid; **filaments** slender, incurving with age; **perianth** of two whorls; **petals** (1) 4-5 (or absent), free, uncleft, often short-clawed and reduced, early-deciduous or concealed by the calyx in self-pollinating species; **sepals** 4-5, free, green or with hyaline or colored margins, sometimes forming a splash-cup that aids in seed dispersal during rain; **pedicels** slender to somewhat thickened; **bracts** of the inflorescence leafy; **cauline leaves** opposite, linear or subulate, connate, sheathing at base; **basal leaves** of perennial species in rosettes; **petioles** absent; **stipules** absent; **stems** decumbent, procumbent or ascending, filiform to thickened and tough at base in perennials; **root systems** annual taproots or tufted, fibrous, perennial roots, sometimes root-sprouting.

KEY TO SPECIES

1. Flower parts primarily in 5's (rarely 4's on the same plant); annuals with erect-ascending (or decumbent) often capillary stems and slender taproots, not strongly tufted or spreading by offshoots . . . . (2)
1. Perianth parts in 4's (rarely 5's on the same plant); matted, wiry perennials, spreading by offshoots . . . . 1. *S. procumbens*
   2. Seeds pale brown, triangular with a dorsal groove; capsules longer than broad; pedicels usually glabrous; leaves not succulent . . . . 2. *S. decumbens*
   2. Seeds dark brown to almost black, plump, lacking a dorsal groove; capsules globose; pedicels glandular pubescent; leaves succulent . . . . 3. *S. japonica*





1. ***Sagina procumbens*** **L.**

Common Names: Pearlwort, Perennial or Spreading Pearlwort

Type Description: Linnaeus, Species Pl. I, p. 128, 1753

Synonyms: *Alsine procumbens* (L.) Crantz, *S. apetala* of some NY reports, not Ard., *S. corsica* Jord., *S. muscosa* Jord., *S. procumbens* var. *muscosa* Jord.

Origin: A native of Eurasia

Habitats: River banks, pond and lake shores, rocky, sandy and gravelly areas, gardens, pathways and waste places

Habit: Procumbent (or ascending), tufted perennials, spreading by offshoots, frequently with well-developed rosettes of leaves

Flowering: May-September

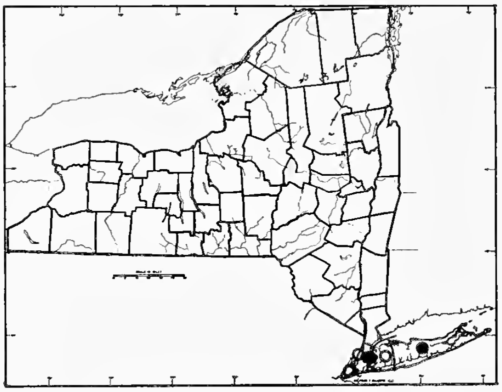
Fruiting: May-October

General Distribution: A native of Eurasia, escaped widely in northeastern North America and the Pacific Northwest, with other scattered occurrences to the Great Lakes States, south to Mexico, Tierra del Fuego and even the Antarctic. Some floras have treated it as a native North American species, but this is very doubtful, considering its history of aggressive, weedy spread from port towns worldwide

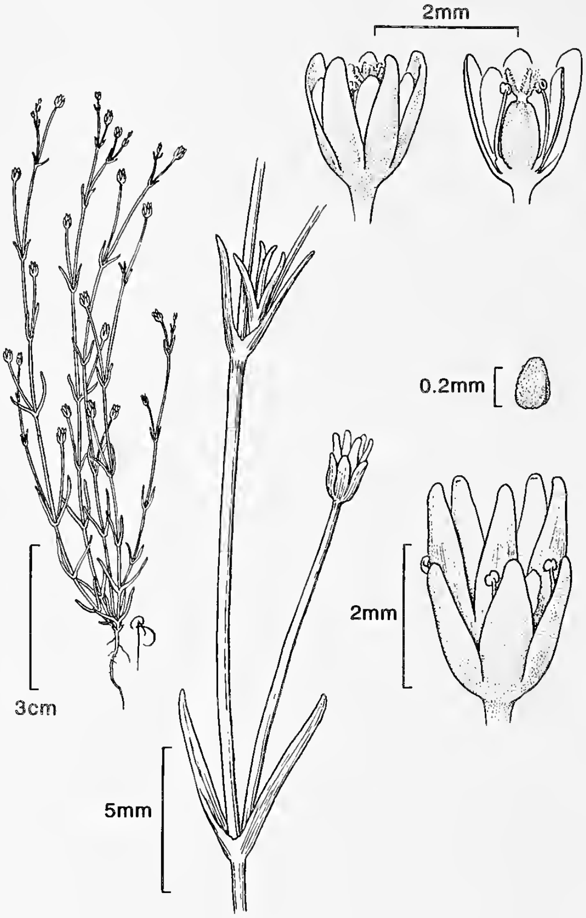
Description: Plants with **bisexual** flowers; **stigmas** 4 (5), papillose receptive areas on the upper styles; **styles** 4 (5), minute, linear, persisting until dehiscence; **ovary** 1, superior, ovoid, ca. 1 mm long; **fruit** a 4-valved capsule, tan, 1.6-3.0 mm long, 1.2-1.7 (2.0) mm broad, dehiscing explosively, the valve tips extended, tongue-like, the spent, exserted capsule up to 3.3 mm long; **seeds** many, brown, minutely tuberculate, 0.2-0.4 mm broad, plumply triangular; **stamens** 4 (8), free; **anthers** minute, yellowish; **filaments** pale, slender, ca. 1.3 mm long, incurved at anthesis; **perianth** of 2 free whorls; **petals** 4 (rarely some flowers on the same plant with 5), ovate-elliptic, 0.7-1.5 mm long and broad, white, caducous; **sepals** 4 (rarely 5) greenish with hyaline margins, 1.1-2.5 mm long and broad, cucullate, with obtuse tips, persisting and divergent after capsule dehiscence, sometimes minutely glandular at base; **pedicels** slender, glabrous, often recurved in fruit; **inflorescence** reduced: **flowers** solitary, terminal, or 2, (with 1 at the penultimate node); **bracts** leaf-like, linear; **cauline leaves** linear, reduced upward on the stem, 2-6 mm long, borne in pairs with hyaline connate bases and apiculate tips; **basal leaves** similar to cauline ones, but larger, 6-16 mm long, often tufted in distinct rosettes; **petioles** absent; **stipules** absent; **stems** procumbent (rarely ascending) glabrous, greenish, 1-8 cm long, spreading by offshoots; **root system** fibrous, perennial, sometimes root-sprouting (2n = 22).

Infraspecific Variation: Depauperate plants from severe, northern shorelines have been called var. *compacta* Lange, but their condition is apparently environmentally induced and clinal, with intermediate individuals bridging a transition to more typical plants nearby.

Importance: These plants are sometimes grown as a ground cover in sandy areas, but this practice is not encouraged, due to the weedy nature of the species.

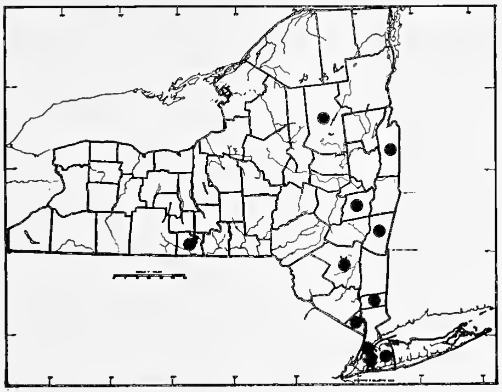


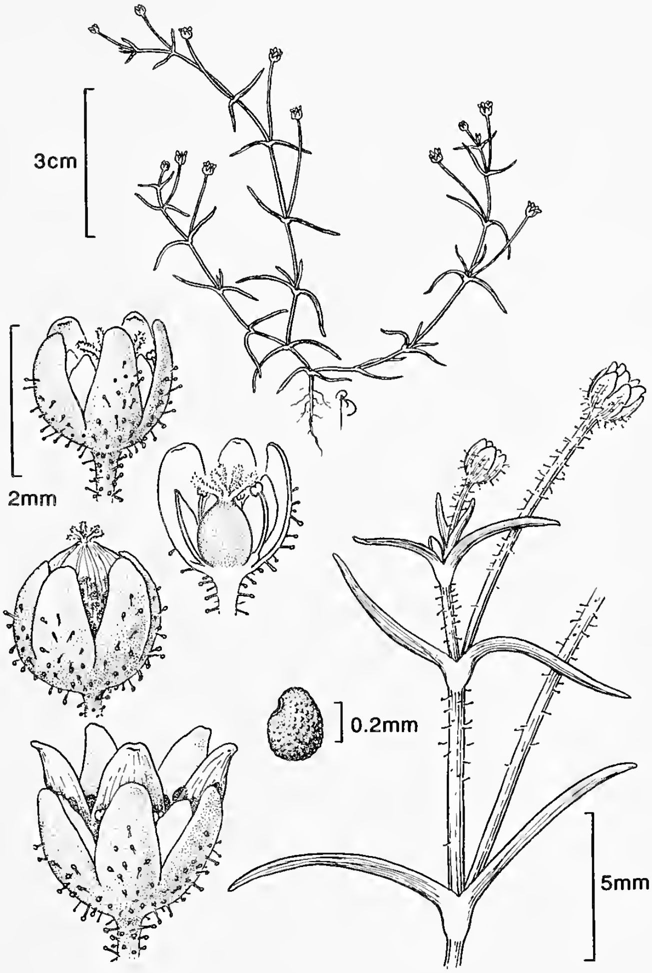
2. *Sagina decumbens* (Ell.) Torr. & Gray
Common Names: Pearlwort, Annual Pearlwort
Type Description: Elliott, Sketch. Bot. S.C. & Ga. I., p. 523, 1821
Synonyms: *Sagina apetala* of some NY reports, not Ard., *S. subulata* var. *smithii* Gray, *S. decumbens* var. *smithii* (Gray) Watson, *Spergula decumbens* Ell.
Origin: A native of North America
Habitats: Sandy soils in partial to full sunlight, pine-scrub, open fields and meadows; a native weed southward on roadsides, lawns, sidewalks and in waste places
Habit: Erect-ascending to decumbent, delicate annuals with slender taproots
Flowering: (April) May-June
Fruiting: May-September
General Distribution: Mainly distributed from New England to Kansas and southward to Texas and Florida; widely disjunct to New Brunswick, Alberta, Saskatchewan and Arizona



Rarity Status: These plants are near the northern edge of their contiguous range in New York State, where they were rediscovered on Long Island in 1991. The Natural Heritage rank is G5 (globally secure) S1 (5 extant sites or fewer), and E (endangered) under State law.
Description: Plants with **bisexual** flowers; **stigmas** (4) 5, papillose receptive areas on the upper style surfaces; **styles** (4) 5, minute, linear, persisting until dehiscence; **ovary** 1, superior, ovoid, ca. 1 mm long; **fruit** a (4-) 5-valved capsule, tan, 1.5-3.1 mm long, 1.0-1.5 (2.1) mm broad, dehiscing explosively, the valve tips then exserted from the perianth, appearing tongue-like, making the spent capsule up to 3.7 mm long; **seeds** 10-many, pale tan, with a dorsal groove, weakly tuberculate to smooth, 0.2-0.7 (1.1) mm broad, plumply triangular; **stamens** 6-10, free; **anthers** minute; yellowish; **filaments** pale, slender, ca. 1.3 mm long, incurving at anthesis; **perianth** of 2 free whorls; **petals** 5 (rarely 4 or absent) ovate-elliptic, 1.2-2.5 mm long and broad, white; **sepals** 5 (rarely 4) greenish with hyaline margins, 0.8-2.2 mm long and broad, cucullate, with purplish, obtuse tips, persisting and appressed after capsule dehiscence, sometimes minutely glandular at base; **pedicels** slender, glabrous or minutely glandular; **flowers** borne singly, terminally or in upper leaf (bract) axils, the diffuse **inflorescence** vaguely cymose; **bracts** and leaves equivalent in the inflorescence; **cauline leaves** linear, 2-13 (22) mm long, borne in pairs, with hyaline connate bases and apiculate tips, greenish, sometimes purple-tinged near the base; **basal leaves** similar to cauline ones, early-withering, not in distinct rosettes; **petioles and stipules** absent; **stems**

capillary, glabrous or minutely glandular, greenish to purple-tinged, erect-ascending or decumbent, 2-12 (16) cm long; **root system** a delicate, thread-like taproot (2n = 36).
Infraspecific Variation: Pubescence is quite variable in this species, especially regarding glandular hairs whose presence or absence varies within populations and even individuals. The tuberculate seed character is also variable within populations, being obscured in some individuals. Slender plants, that are nearly apetalous, often 4-merous and set few seeds, have been called var. *smithii* (Gray) Watson, but Crow (1978) treats such plants as extreme manifestations of a broad range of variability and recommends that no formal taxonomic status be assigned to them. Western North American populations, designated ssp. *occidentalis*, are distinguished by more orbicular sepals, globose capsules and seeds that lack both reticulate ridges and tuberculate surfaces.





3. *Sagina japonica* (Sw.) Ohwi
Common Names: Pearlwort, Japanese Pearlwort
Type Description: Swartz, Gesel. Nat. Freunde (Berlin), Neue Schrift, vol. 3, p. 164, 1801
Synonyms: *S. echinosperma* Hayata, *S. sinensis* Hance, *S. taquetii* Lév.
Origin: A native of eastern Asia
Habitats: Sandy, gravelly places: urban streets, driveways and building foundations; shores of the estuarine Hudson River
Habit: An ascending (rarely decumbent), semisucculent annuals from taproots
Flowering: June-August
Fruiting: June-October
General Distribution: An Asiatic weed, overlooked on the east coast of North America until the 1990s: Massachusetts, Connecticut, New York, Ontario, British Columbia and Oregon
Description: Plants with **bisexual** flowers; **stigmas** 4-5, minutely pubescent; **styles** 4-5, ca. 0.3 mm long, persistent until dehiscence; **ovary** globose, ca. 1 mm broad; **fruit** a globose, 5-valved capsule 1.6-2.2 mm in diameter, valves dehiscing only about 1/4 their lengths, apparently not explosively, walls somewhat translucent showing outlines of the dark seeds within; **seeds** many, 0.2-0.3 mm long, plump, dark brown to ebony, lacking a dorsal groove, the surfaces moderately to densely and prominently tuberculate; **stamens** 5, about equaling the perianth; **anthers** minute, globose, golden; **filaments** pale, slender, 0.9-1.4 mm long; **perianth** of two distinct, free whorls, both often persistent in fruit; **petals** white, ovate with obtuse tips, 1.1-1.6 mm long, 0.7-1.0 mm broad; **sepals** broadly ovate-orbicular with acute to obtuse tips, 0.9-1.8 mm long, 0.7-1.3 mm broad, green with hyaline margins, glandular pubescent on the adaxial surfaces, especially below; **pedicels** slender, 0.3-2.7 cm long, glandular pubescent over the upper half to 2/3 of their length; **bracts** leaf-like, narrowly lanceolate; **inflorescence** reduced to a single terminal flower, or more often 2 flowers, one terminal and the other at the penultimate node; **cauline leaves** paired,

linear, glabrous, 0.5-1.8 cm long, ca. 0.6 mm broad, somewhat succulent, the tips apiculate, bases conspicuously connate, sheathing, hyaline; **basal leaves** similar, persistent, sometimes congested, but not in tufted rosettes; **petioles** absent; **stipules** absent; **stems** capillary, ascending or procumbent, glabrous to glandular-puberulent; **root system** a slender or somewhat thickened, annual taproot with copious, fibrous, lateral branches (2n = 42, 44, 46, 64).

Infraspecific Variation: Measurements of flower parts, capsules and seeds from plants occurring in the eastern United States run somewhat smaller than those reported by Crow (1978) for plants escaping on the West Coast. In addition, most of the East Coast plants have seed walls that are not as densely or prominently tuberculate as those described from the west except for a couple of individuals. Whether these plants have been introduced more than once in Eastern North America is not clear.

Importance: A weed that has turn out to be far more common than expected in the Hudson Estuary; it was first collected in the New York State in the 1940s, but not correctly identified until 1990.

8. MINUARTIA

Common Names: Sandwort, Arenaria

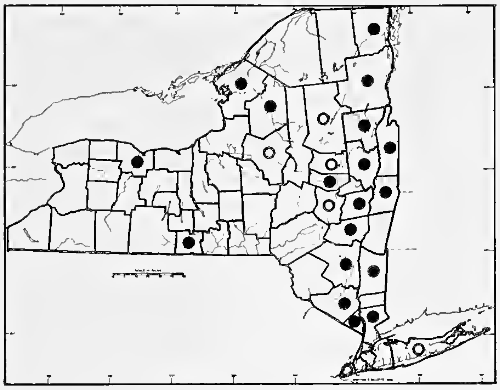
Authority: Linnaeus, Species, Pl. I, p. 89, 1753

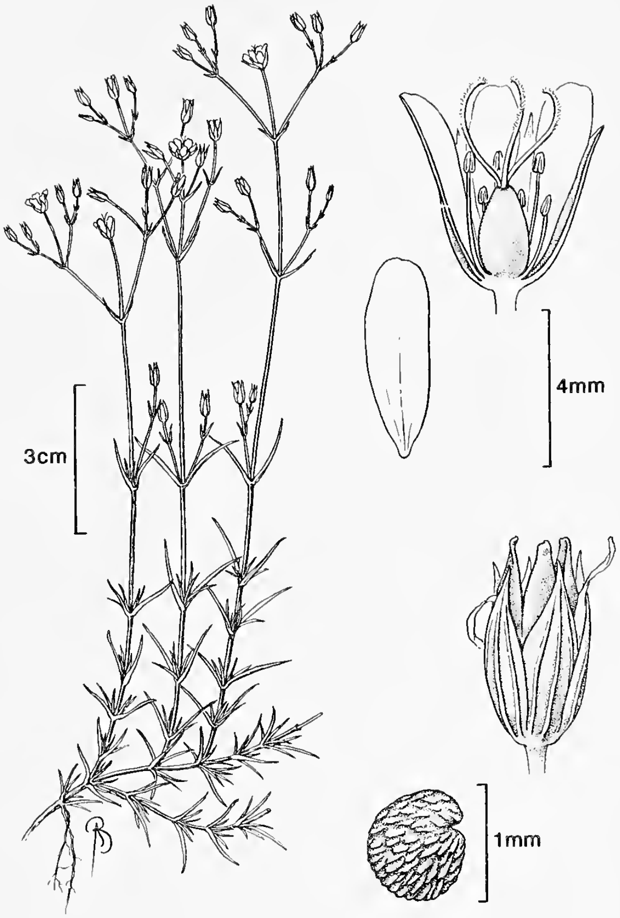
A genus of 100 or more species, native to Eurasia. They have often been included in the genus *Arenaria* in North American treatments, but their fewer, uncleft capsule valves, xeromorphic leaf structure and habit seem sufficient to warrant the recognition of a separate genus, as has been done in Europe for some time.

Description: Plants with **bisexual** flowers; **stigmas** as many as the styles, often 3; **styles** (2-) 3 (-5), free; **ovary** 1, bearing few to many **ovules**; **fruit** a (2-) 3 (-5) valved capsule; **seeds** numerous, small, indented or cleft, some tuberculate or fimbriate; **embryo** arched around a starchy **perisperm**; **stamens** (6-8) 10; **filaments** slender; **anthers** globose; **perianth** of 2 distinct, free whorls; **petals** 5, not deeply cleft; **sepals** 5, greenish, 1-5-veined; **pedicels** and **peduncles** slender; **bracts** often paired, sometimes unequal; **leaves** linear to linear-lanceolate, setaceous or subulate, paired and connate at base; **petioles** obscure; **stipules** lacking; **stems** often wiry, branched throughout or only near the base; **root systems** annual or perennial.

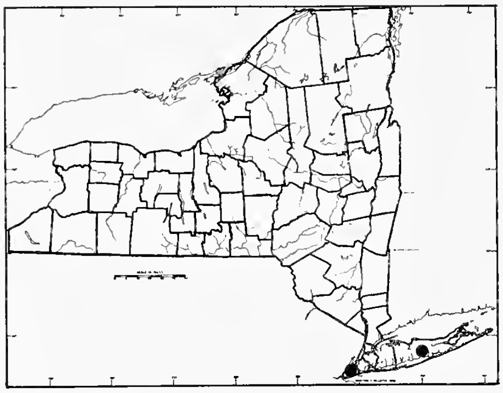
KEY TO SPECIES

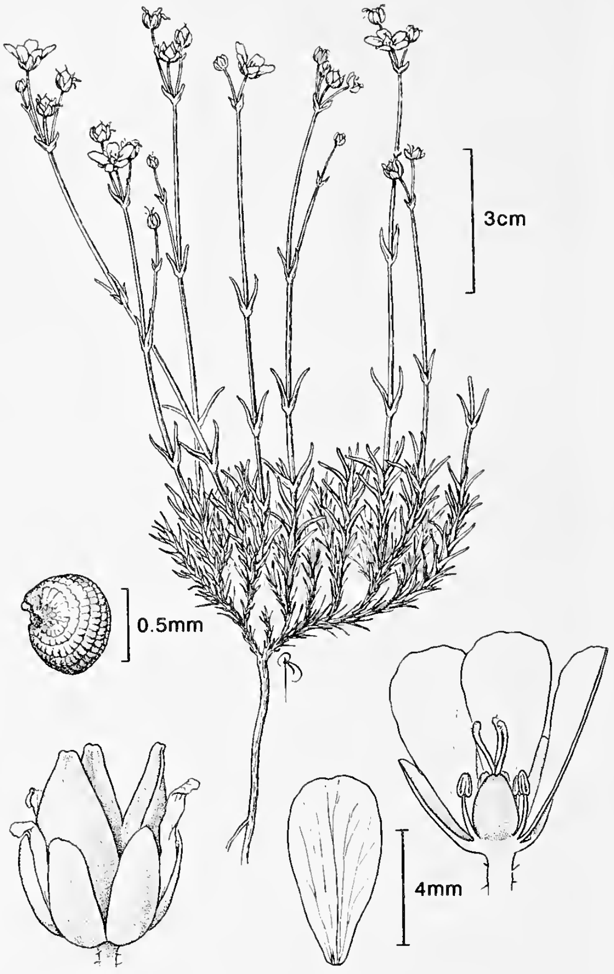
1. Sepals with acute or acuminate tips, strongly ribbed throughout their lengths . . . . 1. *M. michauxii*
1. Sepals with obtuse to rounded tips; not strongly ribbed over their entire lengths (though sometimes ribbed at base) . . . . (2)
    2. Leaves stiff, squarrose, broader toward the base, borne on tough, semi-woody branches from a thick caudex and rootstock; capsule strongly exserted from the calyx; petals not notched or indented at the tips . . . . 2. *M. caroliniana*
    2. Leaves delicate, linear, not strongly broadened at the base, borne on delicate stems from weak to capillary taproots; capsule not strongly exserted; petals usually retuse . . . . (3)
3. Flowering stems weakly ascending, usually less than 5 cm tall; vegetative stem bases matted, profusely branched and densely cespitose; pedicels mostly 1.5 cm or less . . . . 3. *M. groenlandica*
3. Flowering stems erect or strongly ascending, 5-20 (28) cm tall; vegetative bases ranging from single stems to weakly cespitose, but not profusely branched and matted; pedicels ranging up to 3 cm, sometimes longer . . . . 4. *M. glabra*





1. *Minuartia michauxii* (Fenzl) Farw.
Common Name: Rock Sandwort
Type Description: Fenzl, Verbr. Alsin., p. 18, 1833
Synonyms: *Alsine michauxii* Fenzl, *Arenaria macra* Nels. & Macbr., *A. michauxii* (Fenzl) Hook.f., *A. stricta* Michx., *Sabulina stricta* (Michx.) Small
Origin: A native of eastern North America
Habitats: Rocky and gravelly places, limestone flatrock, less frequently on sandy soils and granitic ledges
Habit: Erect-ascending, wiry, annual or perennial herbs, sometimes matted at base, often tufted with short-shoots in the leaf axils
Flowering: May-July
Fruiting: June-September
General Distribution: New Hampshire to western Ontario (*sensu lato* to the Yukon) south to Texas and Arkansas
Description: Plants with **bisexual** flowers; **stigmas** 3; **styles** 3, filiform, free to base, translucent, 1.4-2.1 mm long; **ovary** 1, superior, ovoid; **fruit** an ovoid capsule, 4-5 mm long, ca. 2.5 broad, included or only slightly exserted from the persistent calyx, shiny, tan, dehiscing by 3 entire valves to below the middle; **seeds** many, 0.8-1.2 (1.5) mm long, somewhat compressed, reniform, the dark brown surface rugose; **stamens** 8-10; **anthers** ovoid, golden, minute; **filaments** slender, pale, 3-4 (5) mm long;
perianth of 2 distinct, free whorls; **petals** white, ovoid to obovate with entire margins, 5-8 mm long, 3-5 mm broad; **sepals** 3.8-4.9 mm long, 2-3 mm broad, ovate to broadly lanceolate with acute to acuminate tips, strongly 3 (4) ribbed on the abaxial surface, the margins entire, borders somewhat membranaceous; **pedicels** 0.6-2.0 (3.9) cm long, slender, glabrous; **inflorescences** cymose-paniculate, both terminal and lateral in the upper axils; **bracts** often paired, narrowly deltoid, acuminate, with a prominent midrib and hyaline margins; **leaves** paired and borne in axillary tufts on short-shoots, linear-setiform, 0.5-1.5 (2.9) cm long, ca. 0.2 mm wide, spreading to squarrose, ribbed and grooved, glabrous and glossy green, the bases expanded to clasp the node as a shallow, hyaline cup; **petioles** absent; **stipules** absent; **stems** wiry, branching at the base, producing tufted short-shoots in the upper axils, glabrous, olive-green to reddish-tan, leafy with nodes crowded toward the base, flowering stems diffuse, erect and spreading, up to 30 cm tall; **root system** sometimes annual, but often persisting to become a branched, semi-woody, perennial stock (2n = 30).
Infraspecific Variation: A member of a variable complex, with taxa sometimes treated conspecifically under *M. michauxii* and sometimes split. *Minuartia dawsonensis* (Britt.) House, ranging north and west of our range, is segregated on the basis of shorter petals, marcescent basal shoots and a lack of tufted short-shoots on the upper stems. To the southwest, *M. michauxii* var. *texana* (Robbins.) Mattf. is recognized by its revolute, lanceolate sepals and stiff, densely-branched flowering stems.





2. *Minuartia caroliniana* (Walt.) Mattf.

Common Names: Pine-barren Sandwort, Longroot, Squarrose Sandwort

Type Description: Walter, Fl. Car., p. 141, 1788

Synonyms: *Arenaria caroliniana* Walt., *A. squarrosa* Michx., *Sabulina caroliniana* (Walt.) Small

Origin: A native of coastal eastern North America

Habitats: Sandy, open, coastal areas, beaches, dunes, thickets and oak-pine scrub

Habit: Tufted to cespitose perennials from stout rootstocks; flowering stems strongly ascending

Flowering: (May) June-September

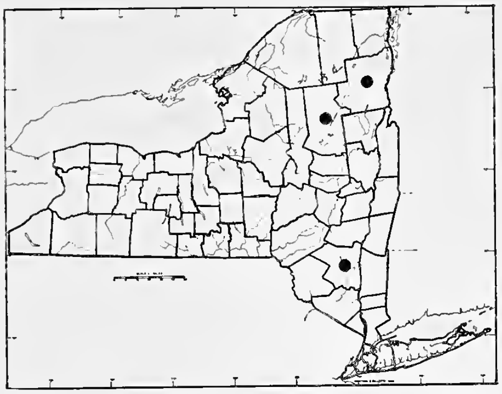
Fruiting: June-November

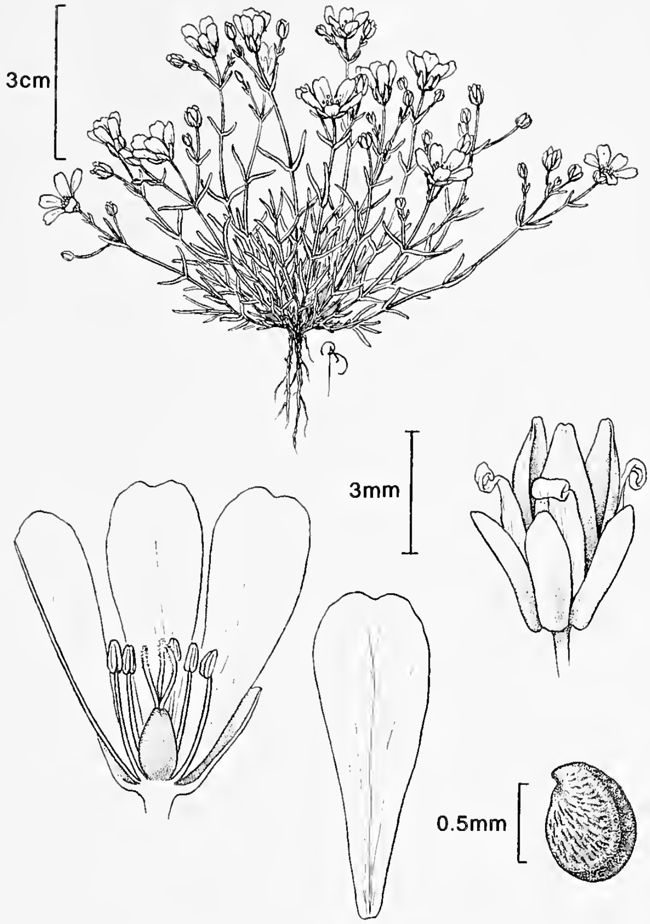
General Distribution: Formerly southern Rhode Island; currently eastern Long Island, New York, scattered along the coast to New Jersey, Virginia, the Carolinas, Georgia and North Florida

Rarity Status: This species is protected under New York State law, listed R (rare), with a New York Natural Heritage rating of G5 S3.

Description: Plants with **bisexual** flowers; **stigmas** 3-4, minutely capitate; **styles** 3-4, filiform, free to base, 0.8-2.8 mm long; **ovary** 1, superior, ovoid; **fruit** an ovoid capsule, variable in size at dehiscence, 5.2-9.8 mm long, 2-5 mm broad, exserted from the persistent calyx, shiny, tan, dehiscing by 3-4 entire valves to below the middle; **seeds** many, 0.7-1.0 mm long, somewhat compressed, surface brown, rugose (seeds often abortive in ours); **stamens** 6-10; **anthers** ovoid, golden, minute; **filaments** slender, reddish, 4-5 mm long; **perianth** of 2 distinct, free whorls; **petals** white, obovate with entire margins, 5-9 mm long, 4-6 mm broad; **sepals** 3.3-5.3 mm long, 1-3 mm broad, ovate with rounded tips, not strongly ribbed, the margins entire, green, the borders somewhat membranaceous; **pedicels** 0.5-2.4 cm long, glandular-hispidulous; **inflorescences** mostly terminal and subterminal cymes; **bracts** often paired, lance-acuminate with hyaline margins; **leaves** paired and crowded near the stem base on short vegetative shoots, linear to lance-subulate, 0.3-1.1 cm long, 0.3-0.9 mm broad, sometimes expanded to over 1 mm at the clasping base, squarrose, often with a prominent midrib, sometimes grooved, glabrous and glossy green; **petioles** absent; **stipules** absent; **stems** densely matted at base, moderately creeping, producing erect, stiff vegetative shoots, glabrous, green to brown, erect flowering stems 5-17 cm tall, with few nodes; **root system** a stout, erect, somewhat woody, perennial stock.

Importance: These plants help to stabilize sandy soils and dunes in the few places where they occur.





3. *Minuartia groenlandica* (Retz.) Ostenf.

Common Names: Mountain Sandwort, Mountain Starwort, Mountain Daisy

Type Description: Retzius, Fl. Scand. ed. 2, p. 107, 1795

Synonyms: *Arenaria groenlandica* (Retz.) Spreng., *Sabulina groenlandica* (Retz.) Small, *Stellaria groenlandica* Retz.

Origin: A native of arctic and boreal North America (montane Brazil)

Habitats: Rocky, gravelly, open places in montane and coastal, arctic and boreal climates: alpine summits, ledges and other acidic, exposed sites in shallow soil and full sunlight

Habit: Plants with densely-branched mat-forming stems, rosettes of needle-leaves and short, slender flowering branches; winter annuals

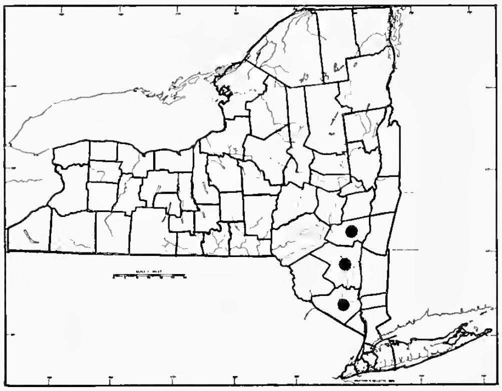
Flowering: (May) June-August

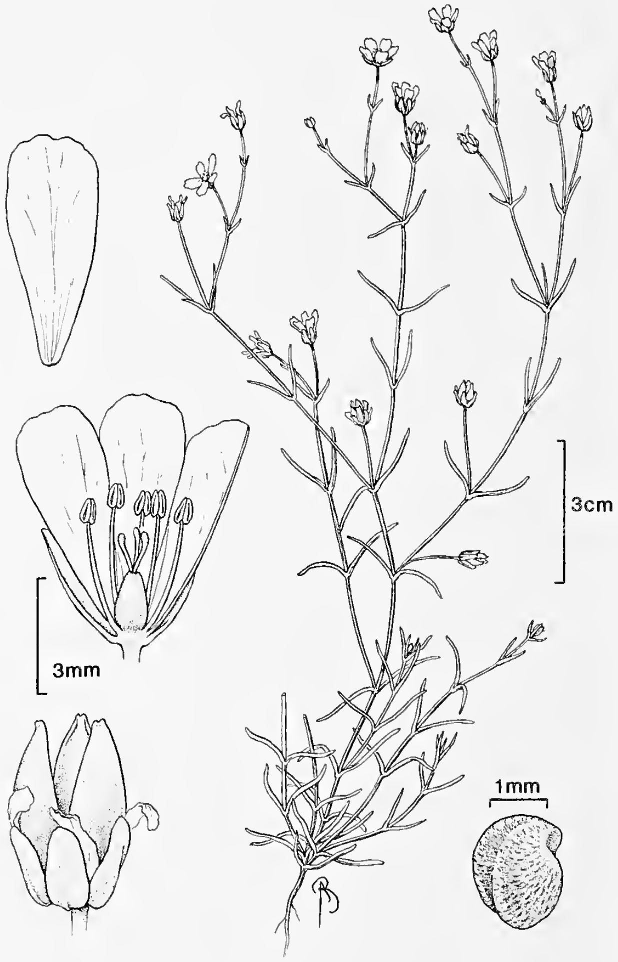
Fruiting: June-September

General Distribution: Greenland to Nova Scotia, northern Quebec and the Gaspé Peninsula, to Maine, Vermont and New York, with outliers south Virginia and the Carolinas; incorrectly reported from Illinois; there is also a confirmed report from montane, southeastern Brazil

Description: Plants with **bisexual** flowers; **stigmas** (2) 3, minutely capitate; **styles** (2) 3, free slender, hyaline, ca. 1.5 mm long; **ovary** 1, fusiform, pale green; **fruit** a capsule, 4.0-5.4 mm long, 1.6-2.3 mm broad, fusiform, 3-valved, dehiscent to near the base, tan, smooth, a remnant of the style base persistent and slightly notched at the apex; **seeds** many, rich reddish-brown, minutely rugulose, 0.6-0.9 mm broad, comma-shaped, indented on both sides and between 2 dorsal ridges; **stamens** 8 (10); **anthers** globose, pale, minute; **filaments** thread-like, hyaline, 3.8-4.7 mm long, somewhat coherent at the bases; **perianth** of 2 series; **petals** 5, alternating with the sepals, 5.7-8.4 (10) mm long, 2.8-3.9 mm at broadest point, spatulate-retuse, the V-shaped notch ca. 0.5 mm deep, petals white, with veins that are somewhat greenish; **sepals** pale green with hyaline margins, 2.6-3.8 mm long, 1.0-1.5 mm broad, ovate to ovate-lanceolate with acute to obtuse tips, the bases yellow-green, scarcely connate, but fusing with the shallow cup of the expanded receptacle; **pedicels** (0.4) 0.6-1.6 (2.2) cm long, wiry, glabrous, pale green, often browning in fruit; **inflorescence** a cyme-like panicle of laterally and terminally borne single flowers, usually numbering 4-7 per flowering stem; **inflorescence bracts** paired (equal in size, or one may be minute), linear, 0.4-3.5 mm long, subterete, flat or grooved, usually somewhat smaller than cauline leaves, usually distinguishable only by the associated axillary pedicels; **cauline leaves** subterete, linear, (1) 2-8 mm long, glabrous, green, browning early, sometimes with a minute, lateral shoot in the axil of one leaf of the pair; **basal leaves** 3-15 (23) mm long, linear to linear-oblanceolate, opposite, crowded into dense mats at the bases of flowering stems and on short, lateral vegetative shoots; **petioles** absent, the leaf bases flattened and clasping; **fruiting stems** erect, 1-8 (15) cm tall, slender, glabrous, green to red-brown, with

2-3 vegetative internodes of 0.8-1.5 cm each above the basal rosette before branching to form the inflorescence; **vegetative stems** copious, less than 1 cm tall, with very short internodes, shiny, pale brown with crowded needle-like leaves; **root system** fibrous, densely spreading from a slender taproot (2n = 20).
Infraspecific Variation: A number of similar taxa have been segregated from this species, particularly south of its contiguous range in eastern North America where they are often found in isolated, specialized habitats. The following species, *M. glabra* (Michx.) Mattf., is one of those taxa (see discussion below).
Importance: This species is one of the early colonizers and soil builders on rocky ledges and alpine summits, along with mosses lichens and *Potentilla tridentata* Soland. ex Ait.





4. *Minuartia glabra* (Michx.) Mattf.
Common Names: Appalachian Sandwort, Mountain Sandwort, Mountain Starwort, Mountain Daisy
Type Description: Michaux, Fl. Bor. Amer. I, p. 274, 1803
Synonyms: *Alsinopsis glabra* (Michx.) Small, *Arenaria glabra* Michx., *A. groenlandica* var. *glabra* (Michx.) Fern., *M. groenlandica* ssp. *glabra* (Michx.) Löve & Löve, *Sabulina glabra* (Michx.) Small
Origin: A native of the Appalachian Shield of North America
Habitats: Acid soils of ledges or in shallow, vernally moist depressions over sandstone conglomerate, usually in full sunlight; cliffs in severe, lichen and moss-dominated habitats where there is little competition
Habit: Winter annuals with tufted rosettes and slender, erect, flowering stems
Flowering: (May) June-September
Fruiting: July-October
General Distribution: Sporadic in montane Maine, New Hampshire, New York and northeastern Pennsylvania
Rarity Status: This species is protected under New York State law considered T (threatened), with a Natural Heritage Program rank of G4G5Q S2.
Description: Plants with **bisexual** flowers; **stigmas** (2-) 3, minutely capitate; **styles** (2-) 3, free slender, hyaline, ca. 1.5 mm long; **ovary** 1, fusiform, pale green, 1.2-1.8 mm long, 0.8-1.1 mm broad; **fruit** 4.2-5.1 mm long, 1.9-2.2 mm broad, fusiform, 3-valved, tan, smooth, a remnant of the style base persistent and slightly notched at the apex; **seeds** many, rich reddish-brown, minutely rugulose, 0.6-0.8 mm broad, comma-shaped, indented on the sides and between the 2 dorsal ridges; **stamens** 8 (-10); **anthers** globose, pale to bright yellow, minute; **filaments** thread-like, hyaline, 3.4-4.1 mm long, cohering slightly at the disc-like receptacle; **perianth** of 2 series; **petals** 5, alternating with the sepals, 5.0-6.4 (-8) mm long, 2.2-3.1 mm at broadest point, spatulate-retuse, the V-shaped notch ca. 0.5 mm deep, petals white, with 4-6 large, often greenish veins; **sepals** pale

green with hyaline margins, 2.9-3.4 mm long, ca. 1.5 mm broad, ovate with acute to obtuse tips, the bases yellow green, scarcely connate, but fusing with the shallow cup of the expanded receptacle; **pedicels** (0.4) 1.0-2.4 cm long, very slender and wiry, glabrous, pale green, often browning in fruit; **inflorescence** a cyme-like panicle of, solitary flowers, usually numbering 9-12 (16) per plant; **inflorescence bracts** paired (equal in size, or one may be minute), linear, 1-6 mm long, subterete, flat or grooved along the upper margin, usually somewhat smaller than cauline leaves, or only distinguishable by the associated axillary pedicels; **cauline leaves** subterete, linear, sessile, (1) 4-12 (15) mm long, glabrous, green, browning early, often with a minute, green, lateral shoot in the axil of one leaf of the pair; **basal leaves** 4-22 (26) mm long, opposite, crowded into dense rosettes at the bases of flowering stems and also on short, lateral vegetative shoots; **petioles** absent, the leaf bases flattened and slightly clasping; **fruiting stems** erect, 9-14 (22) cm tall, slender, glabrous, green to red-brown, with 2-3 vegetative internodes of 1-2 cm each above a basal rosette, branching above to form the inflorescence; **vegetative stems** few, mostly less than 1 cm tall, branching upward from a larger, arched main stem with a shiny, pale brown surface, each short shoot crowned by a dense rosette of needle-like leaves; **root system** fibrous, densely spreading.
Infraspecific Variation and Hybridization: *Minuartia glabra* is frequently listed as a variety of *M. groenlandica*, but it may be distinguished vegetatively by its erect to spreading, rather than mat-forming, habit. The taller flowering stems bear 8-15 flowers that are consistently smaller, on the average, than those of mat-forming *M. groenlandica*, though some overlap in size does occur. A closely related species, *M. uniflora* (Walt.) Mattf. [*M. alabamensis* McCormick *et al.*], is largely restricted to granitic outcrops in the southern Appalachians. *Minuartia glabra* has been reported to occur sympatrically with *M. uniflora* in areas where populations of that species are apparently obligate self-pollinators, and hybrids between the two are not known (Wyatt, 1990).
Importance: This species is one of the early colonizers and soil builders in bare, rocky habitats, establishing soon after lichens and mosses gain a foothold.

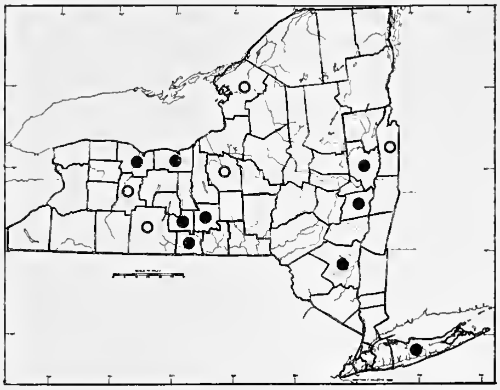
9. CERASTIUM

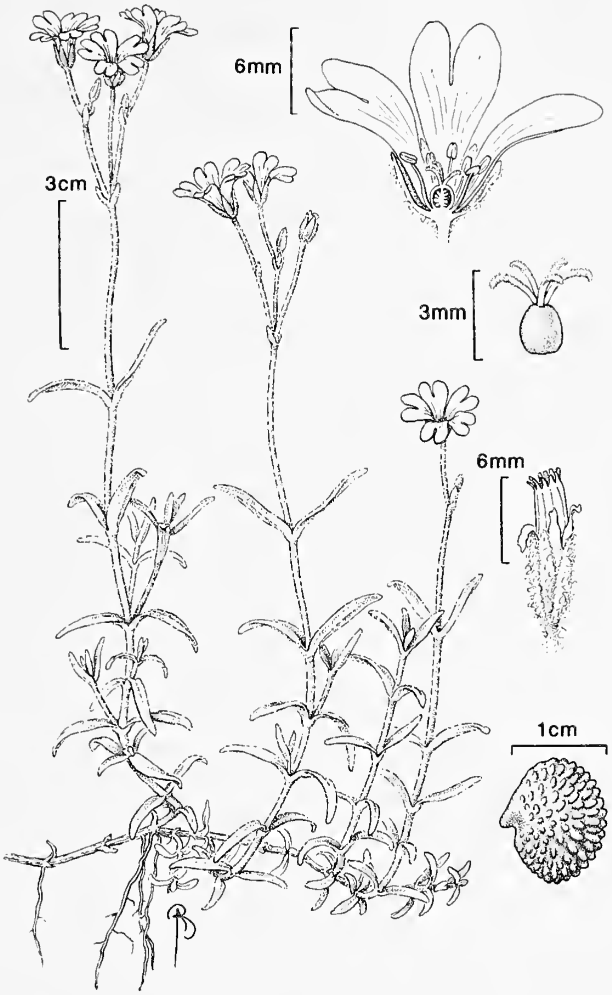
Common Names: Mouse-ear Chickweed
Authority: Linnaeus, Species Pl. I, p 437, 1753
A genus of 100 species or more, distributed widely, mostly in the North Temperate Zone. There are more species in Europe (ca. 60) than in North America, and the genus is also well-represented in Asia. A number of *Cerastium* species, both native and introduced, are weeds of lawns, gardens and streets. The field chickweed (*C. arvense* L.) and two species called snow-in-summer may have showy flowers, and are cultivated in gardens, from which they sometimes escape.
Description: Plants with **bisexual** flowers; **stigmas** (3-4) 5; **styles** (3-4) 5; **ovary** 1, superior, unilocular; **ovules** many, borne on a free central placenta; **fruit** a membranous capsule, often contorted toward the apex, dehiscing by (6-8) 10 hygroscopic teeth surrounding an apical or subapical aperture; **seeds** numerous, usually grooved, papillate or rugulose; **embryo** curved; **stamens** 5-10, free; **filaments** slender; **anthers** globose to oval; **perianth** of 1 or 2 free whorls of 5; **petals** 5 or fewer (sometimes lacking), usually white, emarginate to bifid (rarely entire); **sepals** 5 (rarely 4), free, persistent; **pedicels** usually slender; **bracts** herbaceous or scarious; **inflorescences** often cymose (or flowers solitary in leaf axils); **leaves** opposite, usually entire, clasping at base, ovate to linear; **petioles** absent or obscure; **stipules** absent; **stems** cespitose, usually pubescent, creeping, ascending or erect; **root systems** annual or perennial.

KEY TO SPECIES

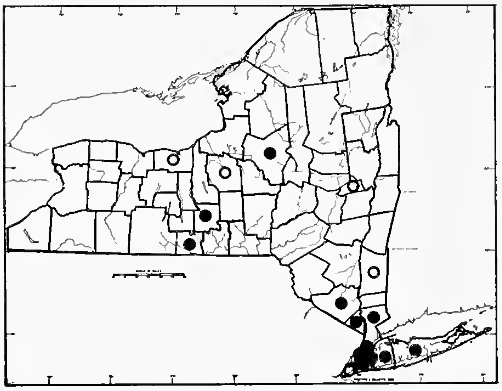
1. Surfaces of the sepals, leaves and stems matted with a dense, woolly tomentum, giving the plant a gray to silvery appearance throughout; flowers often showy, up to 2.5 cm broad .... (2)
1. Surfaces of the sepals variously pubescent, sometimes densely so (to glabrescent), but not matted with a dense, silver wool or tomentum; plants appearing pale to dark green; flowers showy or not ...... (3)
    2. Terminal internode (subtending the inflorescence) about twice the length of the one below it, commonly 8-12 cm long; leaves broadly lanceolate to lance-elliptic, not revolute; capsule teeth flat, not revolute or spreading .... [*C. biebersteinii*][1]
    2. Terminal internode not significantly longer than the one just below it, usually less than 6 cm long; leaves linear to narrowly lanceolate, at least slightly revolute; capsule teeth revolute, often spreading .... 1. *C. tomentosum*
3. Uppermost inflorescence bracts (those directly subtending the pedicels of the flowers) with scarious margins, at least toward the apex, often resembling the sepals .... (5)
3. Uppermost inflorescence bracts herbaceous, leaf-like, the tips and margins not scarious .... (4)
    4. Cauline leaves and bracts broadly elliptic to obovate, mostly less than 4 times as long as broad; calyx with glandular-hispid pubescence, up to 1 mm long; inflorescences densely congested, especially when in flower, but often glomerate, even in fruit .... 2. *C. glomeratum*
    4. Cauline leaves lanceolate, narrowly elliptic to oblanceolate; bracts lanceolate; leaves and bracts mostly 5-8 times as long as broad (or more); calyx pubescence short glandular-villous; inflorescences congested only when young, the axes elongate at maturity .... 3. *C. nutans*
5. Petals showy, exceeding the sepals by 1-2 lengths; leaves mostly linear-lanceolate .... 4. *C. arvense*
5. Petals not showy, shorter, equal or very slightly longer than the sepals; leaves mostly oval to elliptic-lanceolate .... (6)
    6. Fruiting calyces mostly 3-4 mm long; stamens usually 5; the best developed cauline leaves rarely reaching 1 cm in length; annual plants with taproots .... 5. *C. semidecandrum*
    6. Fruiting calyces mostly 5-6 mm long; stamens usually 10; well developed cauline leaves often 1-2 cm or longer; perennials with rhizomes and basal shoots .... 6. *C. fontanum*

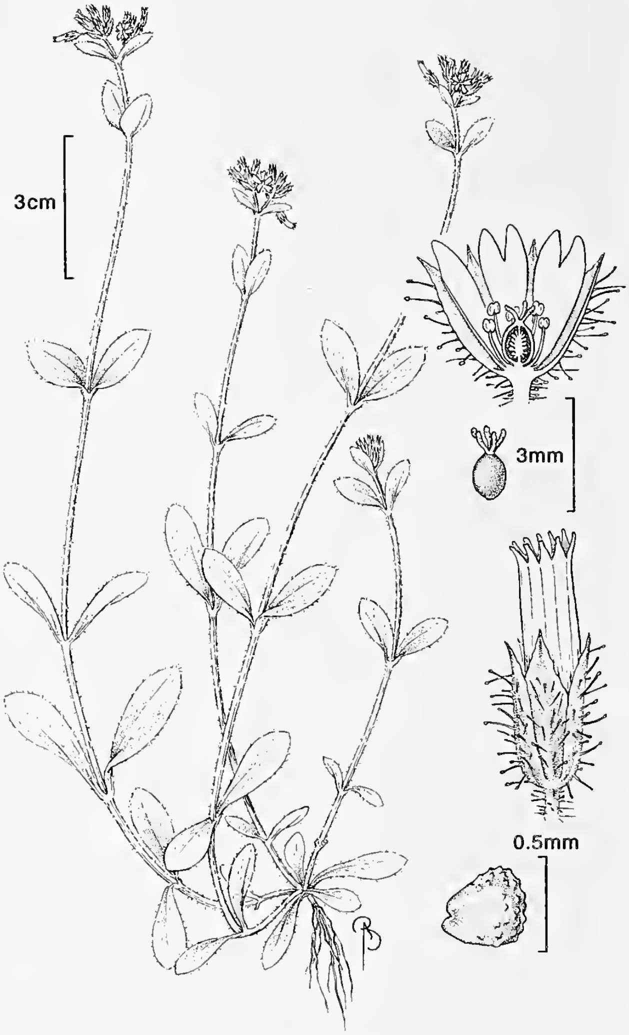
[1]*Cerastium biebersteinii* DC. is a rare garden escape, closely related to *C. tomentosum* L., that is confused with it in both the nursery trade and northeastern floras. At NYS, there is a specimen collected from a garden on Long Island, not far from where an escaped population was found a few years later. The species is planted as a garden novelty and perennial ground-cover in sandy and rocky, open places. Its low-growing, silvery foliage adds a pleasant touch to garden borders.





1. *Cerastium tomentosum* L.
Common Names: Snow-in-summer
Type Description: Linnaeus, Species Pl. I, p. 440, 1753
Synonym: *C. columnae* Tenore
Origin: Native to Mediterranean Europe
Habitats: Roadsides, sandy gullies and rocky shores as a garden escape
Habit: Spreading, matted, perennial herbs with ascending, flowering stem-tips
Flowering: May-July
Fruiting: July-August
General Distribution: A native of Italy; escaping cultivation in relatively frequently in Eurasia, but infrequent as a garden escape in temperate North America
Description: Plants with **bisexual** flowers; **stigmas** 5; **styles** 5, filamentous, 3-4 mm long; **ovary** 1, free, ovoid; **fruit** a cylindric capsule, glossy, greenish-tan, 9-10 mm long, ca. 3 mm broad, not strongly contorted, dehiscing by 10 unequal, erect to spreading teeth with revolute margins; **seeds** few, comma-shaped, 2.3-2.7 mm long, 1.5-1.8 mm broad, red-brown, strongly tuberculate, the lateral tuberculae elongate; **stamens** 6-10, free; **anthers** narrow, ca. 1 mm long; **filaments** linear, 4-6 mm long; **perianth** of 2 free whorls of 5; **petals** white, 8-14 mm long, up to 7 mm broad, entire, notched or bilobed up to 1/3 their length, the petal (lobe) tips entire or minutely erose; **sepals** ovate, 5-8 mm long 3-5 mm broad with obtuse tips and broad hyaline margins, the abaxial surfaces otherwise densely matted with a woolly tomentum; **pedicels** 4-20 mm long, usually densely woolly; **inflorescences** open, few-flowered terminal cymes; **bracts** paired, much like the sepals, 3-8 mm long, 2-4 mm broad, ovate, obtuse, with a heavy tomentum and hyaline margins; **leaves** linear to lanceolate or oblanceolate with acute to obtuse tips, 1-3 (4) cm long, 1-4 (5) mm broad, margins strongly to weakly revolute, entire, surfaces moderately to densely woolly-tomentose; **petioles** and **stipules** absent; **buds** plump, woolly, up to 2 mm long in the lower leaf axils; **stems** yellow-green with a moderate to dense white to silver-gray woolly tomentum, prostrate, branching with ascending tips, up to 35 cm long, from tough, wiry **rhizomes**; **terminal internode** (subtending the flower) similar in length to the one below, usually less than 6 cm long; **root system** perennial, fibrous, largely adventitious (2n = 36, 72, 90, 108).
Infraspecific Variation: Notching and lobing of the petals is variable.
Note: Some plants reported as *C. tomentosum* in northeastern floras are referable to *C. biebersteinii* DC. (see above), but the definitive fruit character is often unavailable for study on herbarium specimens, since they are commonly collected in the showy, early stages of flowering.
Importance: This species is grown as a rock garden plant worldwide. It escapes cultivation primarily in temperate, Mediterranean and Austral climates, very rarely in New York.





2. *Cerastium glomeratum* Thuill.

Common Names: Mouse-ear Chickweed

Type Description: Thuillier, Fl. Paris, ed. 2, p. 226, 1824

Synonyms: *C. apetalum* Dumort., *C. glomeratum* var. *apetalum* (Dumort.) Fenzl, *C. viscosum* of authors, not L.

Origin: A native of Eurasia

Habitats: Pastures, lawns, open woods, cultivated ground and urban clutter as a weed

Habit: Sprawling to erect-ascending, annual herbs

Flowering: (March) May-July

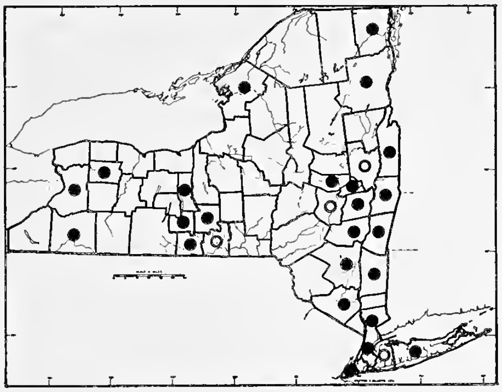
Fruiting: June-September

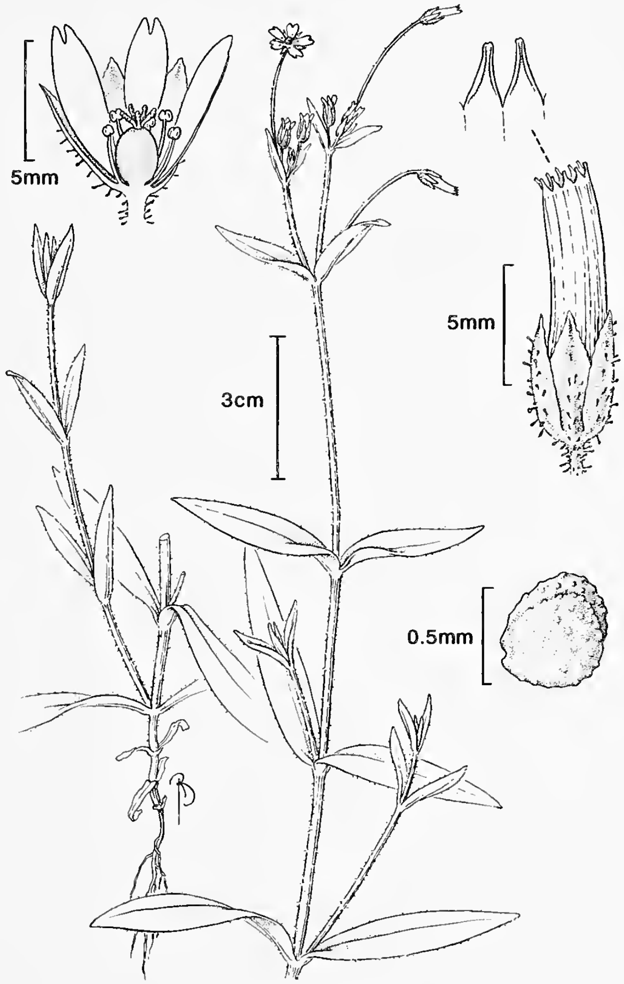
General Distribution: Southern Newfoundland, New York, Connecticut south to Florida, west to Kansas, Texas; British Columbia to California

Description: Plants with **bisexual** flowers; **stigmas** 5, papillose; **styles** 5, linear to moderately clavate, 0.8-1.0 mm long; **ovary** 1, cylindric-ovoid, ca. 2 mm long; **fruit** a slender, cylindric capsule, golden, 4-9 (10) mm long, 1.2-1.8 mm broad, straight to slightly contorted, dehiscing by 7-10 irregular teeth at apex; **seeds** many, pale brown, sparsely papillose, 0.4-0.6 mm long, triangular (pyramidal); **stamens** 7-10, free; **anthers** minute, golden; **filaments** linear, 1-2 mm long; **perianth** of 2 free whorls of 5; **petals** 5 (sometimes fewer or lacking), white, bifid into two slender lobes, 3.1-5.5 mm long, almost equal to slightly exceeding the sepals; **sepals** 5, elliptic-lanceolate, 3.6-5.8 mm long, 0.7-1.4 mm broad, green below with the margins increasingly scarious toward the sharply acute to acuminate tips, adaxial surfaces glandular hispid, with hairs up to 1 mm long; **pedicels** 0.3-4.6 (12) mm long, viscid; **inflorescences** loose, glomerate heads, or expanding into clusters of dense cymes through elongation of the **peduncles** by the time of fruiting; **bracts** herbaceous, broadly oval to ovate-lanceolate with obtuse (acute) tips, 2-12 mm long 1-10 mm broad, the lower ones paired, resembling reduced leaves, margins not scarious, even toward the tips, though the tip may be slightly paler (rarely with a pale mucro), surfaces sparsely to densely glandular-hispid; **leaves** ovate to elliptic, 0.4-3.2 (4) cm long, 0.3-1.5 (2) cm broad, reduced upward, the tips obtusely angled to rounded (or apiculate), the bases obtuse to attenuate, surfaces and entire margins moderately to densely hispid or sericeous; **petioles** absent, indistinct or up to 1.5 cm long with clasping bases, often hispid like the blade; **stipules** absent; **stems** lax to strongly ascending, often densely hispid, up to 60 cm long, sometimes (in ours) congested at base, showing a tendency to proliferate by lateral shoots; **root system** annual, a taproot or diffuse and finely branched (2n = 72).

Infraspecific Variation: In some plants collected in North America there is a tendency to sprout at the base and produce marcescent shoots late in the season. Such variants are clearly like other *C. glomeratum* specimens morphologically, but with an aspect that has caused them to be mistaken for perennial *C. fontanum* Baumg.

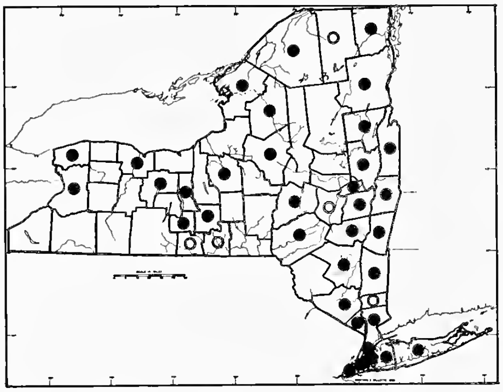
Occasionally inflorescences have a few elongate axes, especially in plants from the western part of the distribution range of the species, but ours consistently have glomerate inflorescences. Some populations have flowers with fewer than 5 petals, and in some places it is not uncommon to find plants in which most flowers lack petals; these were once recognized taxonomically as *C. glomeratum* var. *apetalum* (Dumort.) Fenzl.
Importance: Noxious lawn weeds, especially in the southern states.

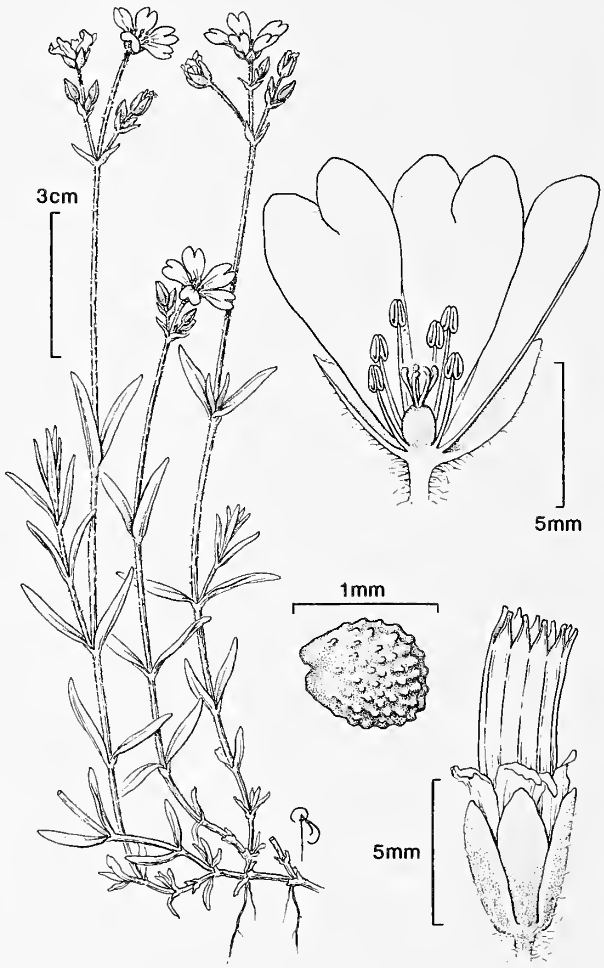




3. *Cerastium nutans* Raf.
Common Names: Nodding Chickweed, Powderhorn
Type Description: Rafinesque, Prec. Decouvr., p. 36, 1814
Synonyms: *C. glutinosum* Nutt., *C.longipedunculatum* Muhl. a *nomen nudum*, *C. tenellum* Fenzl
Origin: A widespread native of North America
Habitats: Cliffs, seeps and rocky woodlands
Habit: Lax to ascending, sparsely-branched, annual herbs
Flowering: (March) April-July
Fruiting: May-September
General Distribution: (Nova Scotia) New Brunswick south to Georgia, Texas and Guatemala; on the West Coast: Mackenzie and British Columbia south to Arizona
Description: Plants with **bisexual** flowers; **stigmas** 5, papillose; **styles** 5, linear, 0.3-0.4 mm long; **ovary** 1, ovoid-cylindric; **fruit** a glossy, tan, somewhat translucent, cylindric capsule, often curved or contorted near the middle, when bearing mature seeds 8.5-12.0 (15) mm long, 2.3-3.4 mm broad at the widest point near the base, dehiscing by 10 subequal teeth with revolute margins; **seeds** many, (0.5) 0.7-0.8 mm long at maturity, comma-shaped, with a flat, dorsal ridge, light reddish-brown, the surfaces boldly tuberculate; **stamens** 6-10, free; **anthers** spheroid, golden, minute; **filaments** linear, ca. 2 mm long; **perianth** of 2 free series; **petals** 5 (or lacking) white, lanceolate to obovate, cleft or uncleft, 1-5 (8) mm long, often approximately equaling the sepals; **sepals** ovate to ovate-lanceolate, 3.5-5.7 mm long, 1.5-2.6 mm broad, green with hyaline margins, especially toward the tips, the adaxial surfaces and margins moderately to densely short glandular-villous, tips acute to bluntly cucullate, the bases rounded; **pedicels** 0.4-3.5 (5.5) mm long, slender, often reflexed just below the calyx in fruit; **inflorescences** of terminal cymes, sometimes dichotomously branched, often few-flowered or flowers in pairs, glomerate only when very young, the pedicels and peduncles elongated and recurved (hooked) in mature flower and fruit; **bracts** herbaceous, ovate to narrowly lanceolate, 2-14 mm long, 0.4-2.7 mm broad, sparsely to moderately glandular-hispid, especially on the margins; **leaves** (0.4) 1-5 (8.3) cm long, 0.2-2.3 cm broad, elliptic to lanceolate or broadly oblanceolate, with acute to obtuse (sometimes apiculate) tips, and oblique bases, entire, the margins and surfaces usually covered with soft, glandular pubescence;

petioles absent or indistinct; **stipules** absent; **stems** slender to somewhat stiff and stout, the larger ones often ridged and grooved, glandular pilose or hispid, 3-40 (60) cm long; **root system** slender, annual (2n = 34, 36). **Note:** Plants with shorter, unreflexed pedicels, obtuse leaf tips and mostly small seeds (0.5-0.7 mm) occur to the south and west, where they are recognized as *C. brachypodum* (Engelm. ex Gray) Robins.





4. *Cerastium arvense* L.

Common Names: Field Chickweed, Meadow Chickweed, Barren Chickweed

Type Description: Linnaeus, Species Pl. I., p. 438, 1753

Synonyms: *C. arvense* var. *oblongifolium* (Torr.) Hollick & Britt., *C. campestre* Greene, *C. oblongifolium* Torr., *C. occidentale* Greene, *C. pennsylvanicum* Hornem. ex DC., *C. pubescens* Goldie, *C. tenuifolium* Pursh, *C. velutinum* Raf., *C. villosum* Muhl.

Origin: Circumboreal in range (possibly both native and introduced in New York State

Habitats: Ledges, rocky woods, meadows, fields and other disturbed ground

Habit: Loosely matted to tufted or cespitose, perennial herbs with lax to strongly erect branch tips

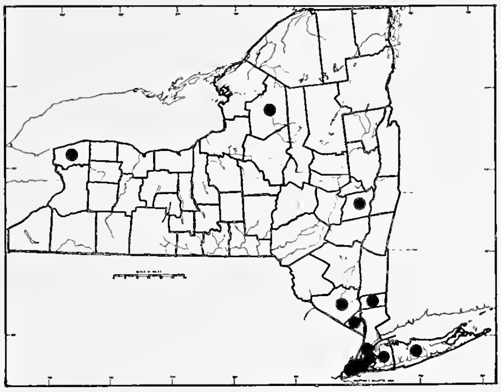
Flowering: April-August

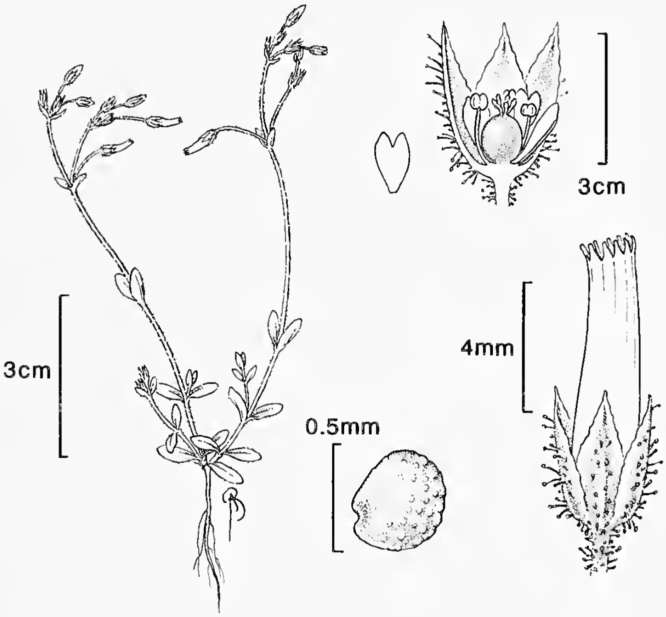
Fruiting: May-September

General Distribution: In North America from Greenland to Alaska, south to California and Tennessee (Georgia); also native across Eurasia.

Description: Plants with **bisexual** flowers; **stigmas** 5, slightly swollen at the tips of the styles; **styles** 5, free, 1.8-2.6 mm long; **ovary** 1, superior, ovoid; **fruit** a capsule, 6-11 mm long, 2-3 mm broad, tan, glossy, dehiscing by 8-10 terminal teeth with revolute margins; **seeds** (0.4) 0.6-0.9 (1.1) mm long, comma-shaped with 2 prominent dorsal ridges, red-brown with moderately to prominently tuberculate surfaces; **stamens** 8-10, free; **anthers** golden, oblong, ca. 0.9 mm long; **filaments** slender, 3-7 mm long; **perianth** of 2 free whorls of 5; **petals** white, 6-10 (16) mm long, 3-9 mm broad, the tips obtuse, entire (or fimbriate), emarginate or bilobed, cleft up to 1/4 their length; **sepals** 4.5-8.9 mm long, 1-2 mm broad, elliptic, with acute to obtuse (notched) tips, green with scarious margins and tips, the adaxial surface glandular-pilose to moderately velutinous; **pedicels** 0.3-3.0 (4.2) cm long, glabrescent to pilose (or velutinous); **inflorescences** of terminal cymes with some single and paired flowers in the upper axils; **bracts** greenish with narrow to broad scarious margins toward the tips, 2-4 mm long, ca. 1 mm broad, hispid; **leaves** linear-acicular to elliptic-lanceolate, cauline leaves mostly 1-3 (7) cm long, 1-4 (9) mm broad, acute to acuminate (or blunted at tips), margins hispid, the surfaces glabrescent to hispid or pilose (rarely glandular); **petioles** and **stipules** absent; **stems** wiry, sparsely to densely retrorse-hispid or pilose (sometimes glandular), branched, matted and congested at the bases to lax and sprawling, the flowering branch

tips lax to strongly ascending; **short shoots** commonly borne in the leaf axils, densely tufted with needle-like leaves; marcescent **vegetative shoots** commonly clustered at the stem bases; **root system** perennial, largely adventitious from wiry stolons (2n = 36, 72, 90, 108).
Infraspecific Variation: This species is polymorphic, both in Eurasia and in North America, and cultivars have also been artificially bred for horticulture. Flower size, petal lobing, leaf shape, pubescence, capsule length and habit of the plant provide characters that have been historically used to delimit taxa within the complex. Further study has tended to proliferate the number of infraspecific taxa and contribute little to knowledge of the worldwide pattern of variation. Until a global study of the group is carried out, the use of polynomial designations is discouraged, except for convenience, where horticultural races are concerned.
Importance: Field Chickweed is grown as a rock garden plant around the world, and its many morphological variants occur widely as weeds as well as in their native habitats.



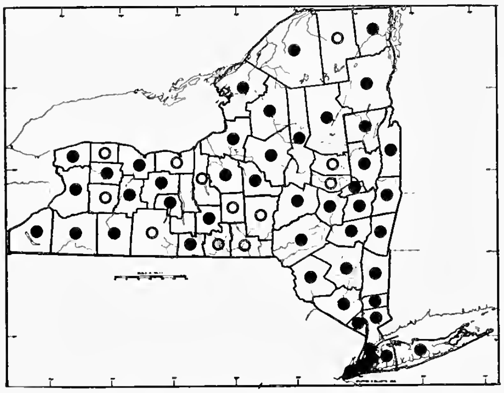


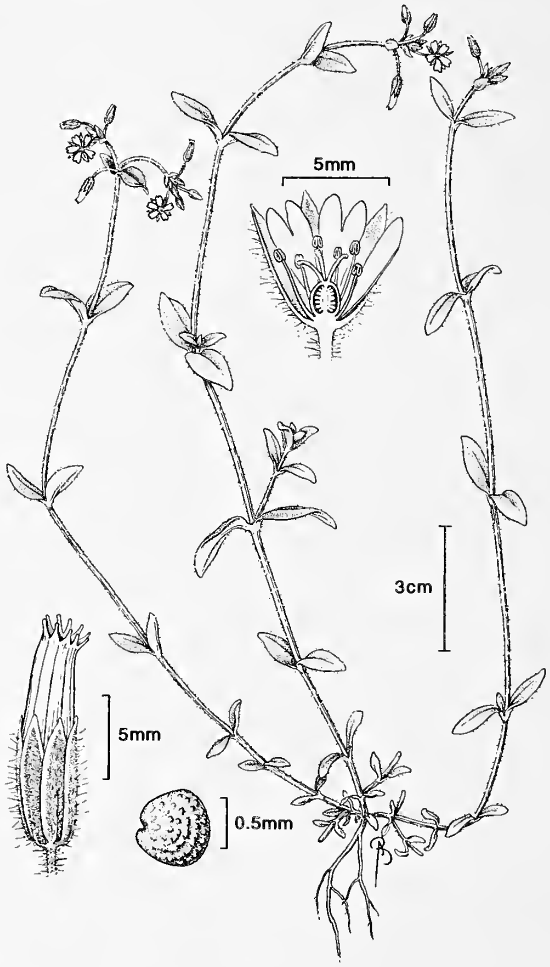
5. *Cerastium semidecandrum* L.
Common Names: Small Mouse-ear Chickweed, Spring Chickweed
Type Description: Linnaeus, Species Pl. I., p. 438, 1753
Synonyms: *C. vulgatum* var. *semidecandrum* (L.) Gray
Origin: A native of Eurasia
Habitats: Sandy, open places, especially on shores on the Coastal Plain and Lake Plains
Habit: Decumbent to ascending, annual herbs, often diminutive and much branched at the base
Flowering: Late March-June
Fruiting: April-August
General Distribution: Eurasia; Massachusetts, New York and southern Ontario to the Great Lakes and Midwest, south to the Carolinas and Gulf Coast of Louisiana as an adventive
Description: Plants with **bisexual** flowers; **stigmas** 5, papillose up to 3/4 the style length; **styles** 5, free, filamentous, ca. 0.8 mm long; **ovary** 1, superior, ovoid; **fruit** a greenish-tan, glossy, semi-opaque, cylindric capsule, straight or curved, 4.4-7.2 mm long, 1.1-1.5 mm broad, dehiscing by (9) 10 teeth with revolute margins; **seeds** many, comma-shaped, plump, 0.4-0.5 mm long, pale brown with a few prominent tubercles, or very weakly tubercled; **stamens** 5 (9-10), free; **anthers** minute, golden, **filaments** pale, linear, 2-3 mm long; **perianth** of 2 free whorls of 5; **petals** white, elliptic to lanceolate with obtuse or acute tips (or slightly notched), 2.1-3.2 mm long; **sepals** elliptic to ovate-lanceolate, 2.8-4.3 mm long, ca. 1 mm broad, green with broad, scarious margins toward the tips, sometimes tinged with purple, glandular to short-hispid on the adaxial surfaces; **pedicels** 1-9 mm long, erect or deflexed after anthesis, often densely glandular, short-hispid; **inflorescences** relatively dense terminal cymes, with a few flower pairs and clusters in leaf axils of robust individuals; **bracts** directly subtending the flowers, ovate to elliptic, 2-3 mm long, with scarious margins and tips (to almost entirely scarious), glandular-hispid, the lower bracts of the inflorescence more leaf-like and paired; **leaves** oval

to elliptic-obovate or somewhat spatulate with obtuse tips, 2-8 (13) mm long, 2-7 mm broad, moderately to densely hispid to glandular; **petioles** and **stipules** absent; **stems** simple to much-branched from near the base, glabrescent to densely glandular-hispid, slender, ascending or decumbent, up to 25 cm long; **root system** an annual taproot with delicate lateral branches (2n = 36).

Infraspecific Variation: Glabrous individuals are known in Europe, but none have been collected in our range. The stamens are usually five, but occasionally there are 9 or 10, the usual condition for plants of this genus.

Taxonomic Note: *Cerastium pumilum* Curtis is a very similar European introduction that has been reported from Kings, Chemung and Steuben Counties. These plants have tetraploid (2n = 72) chromosome numbers (or higher), and differ from *C. semidecandrum* in having more erect pedicels in fruit; the scarious bract tips and margins are less conspicuous, and the petals barely exceed the sepals.





6. *Cerastium fontanum* Baumg. *emend.* Jalas ssp. *vulgare* (Hartm.) Greuter & Burdet

Common Names: Mouse-ear, Common Chickweed

Type Description: Baumgarten, Enum. Stirp. Trans. vol. 1, p. 425, 1816, *emend.* Jalas, Arch. Soc. Zool.-Bot. Fenn. Uanamo, vol. 18, p. 62, 1963

Synonyms: *C. caespitosum* Gilib., *C. fontanum* ssp. *triviale* of NY authors, not (Link) Jalas, *C. holostoides* Fries, *C. glomeratum* of authors, not Thuill., *C. vulgatum* of authors, in part.

Origin: A native of Europe

Habitats: Disturbed open sites: roadsides, lawns, meadows and fields to open woods and swamps

Habit: Spreading, matted, perennial herbs with ascending flowering shoots and short, marcescent vegetative shoots from basal rhizomes

Flowering: April-July (September-November)

Fruiting: May-August (October-December)

General Distribution: Newfoundland to Alaska south to Mexico, Texas and Florida

Description: Plants with **bisexual** flowers; **stigmas** 5, papillose over 3/4 the style length; **styles** 5, free, capillary, 0.8-1.7 mm long; **ovary** 1, superior, ovoid; **fruit** a tan, glossy, somewhat translucent capsule, cylindric, usually curved, 6-10 (12) mm long, 1-3 mm broad, dehiscing by 8-10 teeth with revolute margins; **seeds** plump, trapezoidal to pyramidal, 0.4-0.7 (1.2) mm long, red-brown, with tubercles less than twice as wide as tall; **stamens** 5 (rarely 8-10), free; **anthers** golden, ovoid; **filaments** linear, 3-5 (8) mm long; **perianth** of 2 free whorls of 5 (or petals absent); **petals** white, 4-6 mm long, 1-3 mm broad, emarginate to bilobed, cleft up to 1/3 of their length; **sepals** ovate-lanceolate, 5.2-8.3 (9) mm long, 1-3 mm broad, with acute to blunted tips, green or reddish-tinged with hyaline margins and tips, the midvein prominent at the sepal base; **pedicels** 1-9 (13) mm long, reflexed just below the calyx in fruit, densely hirsute (glandular); **inflorescences** glomerate at first, usually elongating to become open, terminal cymes; **bracts** at the inflorescence base paired, leaf-like, the floral bracts above ovate, 1-3 mm long with scarious margins toward the tips, hispidulous with ciliate margins;

leaves lance-ovate, strap-like, elliptic, obovate or spatulate, 3 times longer than wide (or more), the tips usually obtuse (mucronate or acute), with entire margins, 2-35 (41) mm long, 1-12 (15) mm broad, hirsute (to glandular) on both surfaces and margins; **petioles** and **stipules** absent; **stems** decumbent or ascending up to 70 cm, hirsute to glandular with marcescent vegetative shoots at base and matted stolons and rhizomes; **root system** largely adventitious (2n = 72, 144, 162).

Infraspecific Variation: This is an extremely variable species in Europe, where it is native and widespread as a weed. In New York State, plants similar to ssp. *fontanum* in sepal size occur, but these often have smaller seeds. They have recently been treated as ssp. *triviale* (Link) Jalas., even though ssp. *triviale* is said to differ from its nearest relatives in Europe by having a combination of short sepals and small seeds, with prominent, symmetrical tubercles. The trend in European infraspecific classification has been to recognize plants like those found in eastern North America as ssp. *vulgare* (Hartman) Greuter & Burdet. Three of four subspecies in the European flora are reported to have the same high chromosome number (2n = 144), so introgression may well have occurred. Varieties of so-called *C. vulgatum* L. treated in North American manuals were based on variable pubescence and leaf shape not consistent enough to warrant recognition.

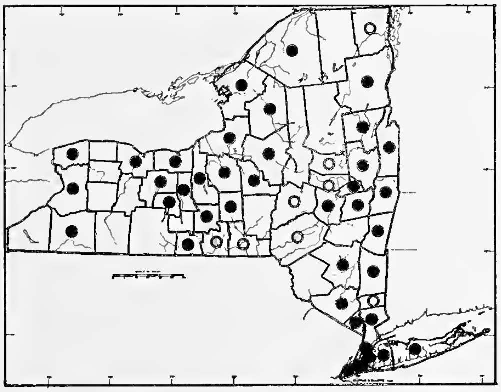
Importance: A noxious weed, very persistent in lawns and gardens, and resistant to most herbicides.

10. MOEHRINGIA

Common Name: Sandwort

Authority: Linnaeus, Species Pl. I, p. 359, 1753

A circumboreal, but primarily Eurasian genus of 30 species, two of which occur as natives in North America.



1. *Moehringia lateriflora* (L.) Fenzl

Common Names: Grove Sandwort, Blunt-leaf Sandwort

Type Description: Linnaeus, Species Pl. I., p. 423, 1753

Synonyms: *Arenaria angustifolia* Regel, *A. lateriflora* L., *Stellaria biflora* Pursh

Origin: Circumboreal

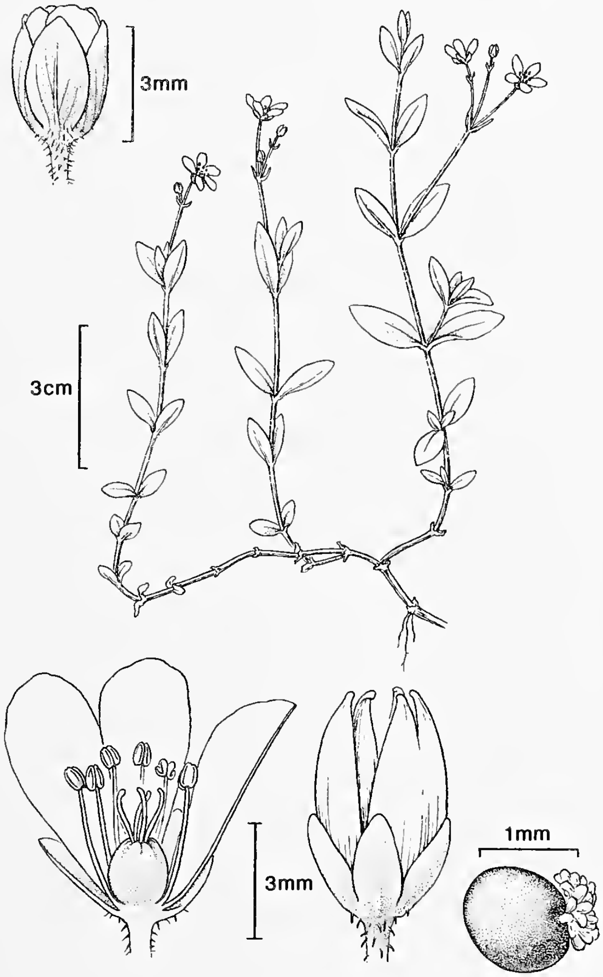
Habitats: Woodland borders, swamps, meadows, thickets and shores, in moist, mucky or gravelly soils

Habit: Rhizomatous, perennial herbs with spreading branches

Flowering: May-August

Fruiting: June-October

General Distribution: Circumboreal in temperate areas; North America from Newfoundland to Alaska, south to New Mexico and Maryland

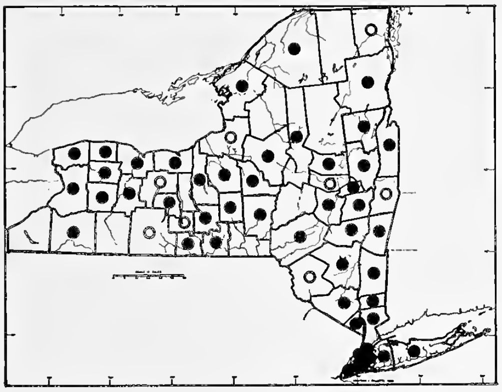


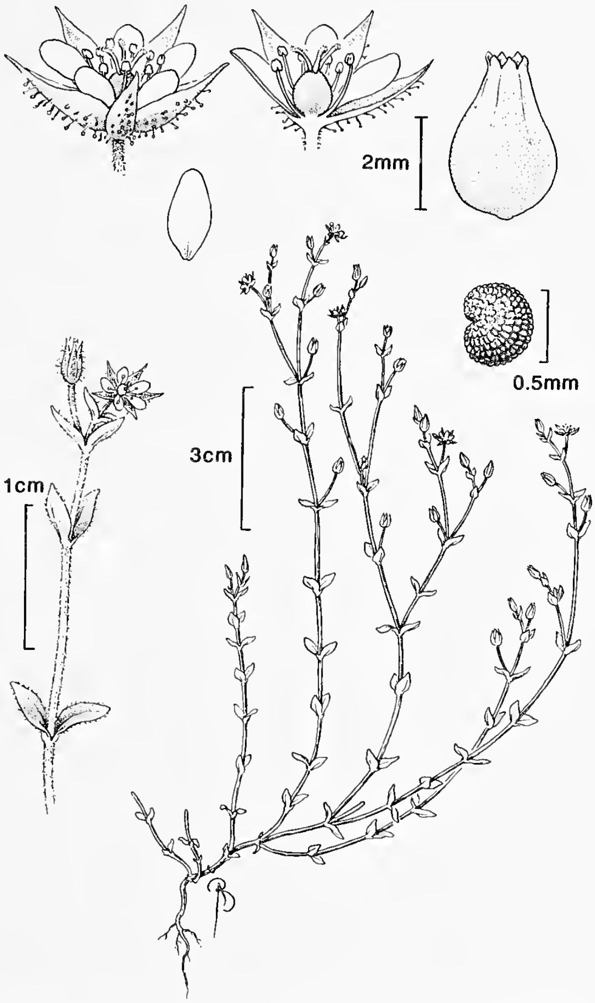
Description: Plants with **bisexual** flowers (plants sometimes functionally dioecious); **stigmas** 3-4 (5), slightly expanded at style tips; **styles** 3-4 (5), borne at the tips of the ovary lobes, sometimes 2 (3) styles from a single lobe, united below; **ovary** 1, superior, 3-5 (6) lobed above, the lobes sometimes appearing like distinct carpels (the extreme ones clavate-tipped), ovary apex elongating and expanding between the lobes during fruit development; **fruit** a tan, lustrous capsule, ovate-lanceolate to conic, 3-7 mm long, 1-4 mm broad, with acute, lobed tips, dehiscing to become (5) 6 toothed, often more deeply 2-cleft to near the base along opposite sutures, the teeth erect to somewhat spreading; **seeds** several, red-brown to almost black, coarsely rugulose, ovoid, 0.9-1.3 mm long, often with a pale, spongy strophiole at maturity; **stamens** (8-) 10 (11), free; **anthers** globose, ca. 0.2 mm; **filaments** linear, 2-4 mm long; **perianth** of 2 distinct, free whorls; **petals** 5, white to pinkish, ovate-obovoid, 3.4-7.0 (8.3) mm long, 2.0-6.7 mm broad; **sepals** 5, elliptic to obovate, 2.1-3.1 mm long, 0.8-1.6 mm broad, entire with obtuse to acute tips, weakly to strongly 3-nerved the central nerve often lined with short, bristle-like hairs, surfaces pale green with hyaline margins; **pedicels** slender, 0.4-1.7 (2.3) cm long, yellow-green, with few to many minute, retrorsely hooked hairs; **bracts** subtending the pedicels and peduncles paired, 1-2 mm long, linear to broadly lanceolate, puberulent; **peduncles** like the pedicels, up to 4 cm long; flowers often borne in terminal pairs (or singly), sometimes overtopped by a flower from an inflorescence axil, or **inflorescence** a 3-4 (6-) flowered cyme; **leaves** paired, elliptic-ovate to narrowly oblong, (0.3) 1-3 (3.7) cm long, (0.2) 0.6-2.5 cm broad, entire with obtuse bases and obtuse to subacute tips, obscurely clasping at base, the surfaces glandular-punctate, puberulent to short-villous on the margins and adaxial veins; **petioles** lacking; **stipules** lacking; **stems** slender, greenish to pinkish-tan, glabrous to retrorsely puberulent or densely short-villous, especially at the nodes, laterally branching, the main axis somewhat weak and sprawling, mostly 10-20 (up to 40) cm long; **rhizome** slender and often extensive, with scale-like leaves at the nodes; **root system** fibrous, adventitious ($2n = 24, 48$).

Infraspecific Variation: This species ranges to northern Eurasia, where most other species of the genus occur as endemic relicts. Its unusual variation in floral structure suggests that it is among the more primitive members of the family, possibly having evolved as far back as the Cretaceous. In early stages of development, the ovary may be swollen, with inconspicuous terminal lobes, or the lobes may be elongate and club-like, with appearance of separate carpels when viewed from above. The whole aspect of the flower is much like that of a saxifrage prior to fruit development. The somewhat erratic development of the ovary leads to some variation in size and morphology of the mature fruits, which range from small, primarily 2-valved structures bearing only a few ripe seeds through a series of larger capsules, the best developed of which dehisce by 5-6 teeth and split to near the fruit base. *Moehringia macrophylla* Hooker is a closely related, widespread species in North America, differing from ours in leaf, bract, sepal and capsule shapes. Its distribution range is primarily Western Cordilleran, but it occurs sporadically in the east, and as close to New York as Vermont.

11. ARENARIA

Common Names: Sandwort, Starwort
Authority: Linnaeus, Species Pl. I, p. 423, 1753
A genus of up to 300 species of primarily Old World plants, many of which are sun-loving and occur in sandy and rocky habitats. In this publication, *Minuartia* and *Moehringia* and *Honckenya*, often considered congeneric with *Arenaria* in earlier North American floras and manuals, are treated separately.



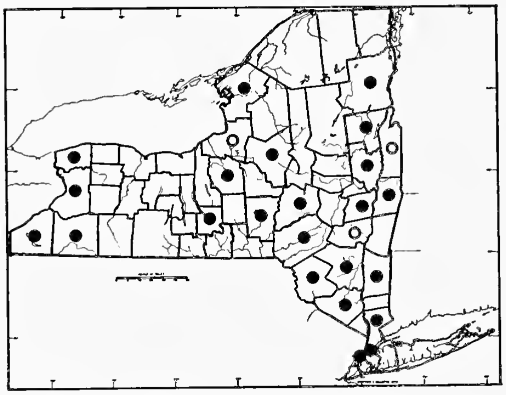


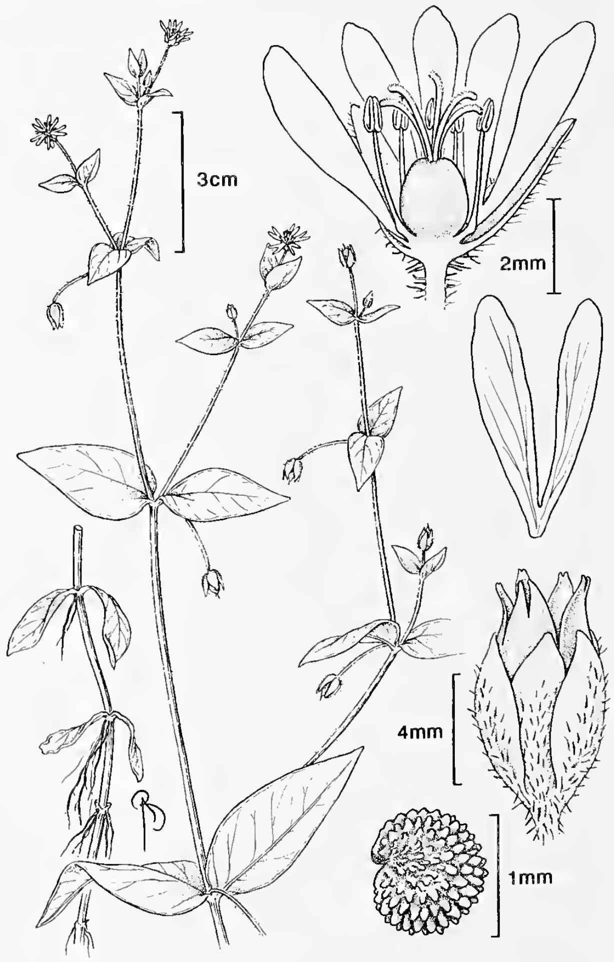
1. *Arenaria serpyllifolia* L.
Common Names: Thyme-leaf Sandwort
Type Description: Linnaeus, Species Pl., p. 423, 1753
Synonyms: *A. leptoclados* (Reich.) Guss, *A. serpyllifolia* ssp. *leptoclados* (Reich.) Nymer; *A. serpyllifolia* var. *tenuior* Mert. & Koch, *A. tenuior* (Mert. & Koch) Gürke
Origin: A native of Eurasia
Habitats: Dry, sunny, sandy or gravelly waste places, fields, roadsides, quarries and ledges
Habit: Annual herbs, often profusely branched with slender taproots
Flowering: April-September
Fruiting: May-November
General Distribution: A native of Europe and northern Asia, widespread as a weed virtually throughout the temperate world
Description: Plants with **bisexual** flowers; **stigmas** 3, papillose areas at the style tips; **styles** 3, filiform, spreading, ca. 0.7 mm long; **ovary** 1, superior, ovoid; **fruit** an olive-tan, glossy capsule, pyriform to cylindric, 3-5 mm long, ca. 3 mm broad near base, dehiscing by 6 triangular, apical teeth; **seeds** many, golden to dark brown, semi-glossy, rugose, reniform, 0.5-0.7 mm long; **stamens** 6-8 (10), free; **anthers** minute, golden, globose; **filaments** thread-like, 0.5-1.2 mm long; **perianth** of 2 distinct, free whorls; **petals** 5, obovate, 1.3-2.4 mm long, entire or minutely notched at tip, white; **sepals** 5, ovate at base with lance-acuminate tips, 1.8-3.6 mm long, 0.4-1.0 mm broad at base, glandular-hispid on the adaxial surface, the central 1/2-2/3 of the structure a green band with 1-3 (3-5) major veins, the midrib usually prominent, margins hyalin; **pedicels** 1-14 mm long, minutely glandular-hispid, sometimes retrorsely; **bracts** minute, leaf-like up to 6 mm long and 3 mm broad; **peduncles** like the pedicels; **inflorescence** a diffuse dichasium with single flowers pairs and clusters borne terminally and in the axils throughout all but the lower portions of the plant; **leaves** oval to ovate-lanceolate, acute to acuminate or apiculate, with obtuse, minutely clasping bases, 1-6 (8) mm long, 0.6-5.4 mm broad, the surfaces glandular punctate or pustulose, scabrescent (to glandular-hispid), especially along the veins and entire leaf

margins; **petioles** absent; **stipules** absent; **stems** wiry, usually much-branched from near the base, sparsely to densely, retrorse-scabrescent, 3-30 (36) cm, spreading; **root system** a slender, annual taproot (2n = 20, 40).
Infraspecific Variation: Some authors have recognized up to four subspecies of *A. serpyllifolia*, including a taxon based on slightly shorter, more cylindric capsules and a more delicate vegetative habit. These characters have been used to distinguish *A. leptoclados* from *A. serpyllifolia* L. Plants reported as *A. serpyllifolia* var. *macrocarpa* Lloyd (a *nomen illeg.*), from the Atlantic coast of Europe, also occur in New York State. These are distinctive in appearance in that the upper leaves and bracts are broad and often crowded beneath short-pedicelled flowers at the stem apices.

12. MYOSOTON

Common Names: Giant Chickweed, Water Mouse-ear
Authority: Moench, Meth., p. 225, 1794
A monotypic genus of the Old World, historically included in the genus *Stellaria*.





1. *Myosoton aquaticum* (L.) Moench
Common Names: Giant Chickweed, Water Mouse-ear (Chickweed)
Type Description: Linnaeus, Species Pl. I., p. 439, 1753
Synonyms: *Alsine aquatica* (L.) Britt., *Cerastium aquaticum* L., (*Malachia*) *Malachium aquaticum* (L.) Fries., *Stellaria aquatica* (L.) Scop.
Origin: A native of northern Europe
Habitats: Stream courses and shores, wet meadows, thickets, swamp clearings and moist waste places
Habit: Sprawling to ascending, perennial herbs
Flowering: (May) June-October
Fruiting: June-November
General Distribution: A native of Europe, naturalized in North America from New England to Minnesota (also B.C.), sporadically southward to Missouri and the Carolinas (Louisiana)
Description: Plants with **bisexual** flowers; **stigmas** 5, papillose zones lateral to the styles and ca. 1/2 their length; **styles** 5, filamentous, 1.6-2.0 mm long, free, divergent to recurved; **ovary** 1, superior, ovoid, ca. 2.5 mm long; **fruit** an ovoid-cylindric to pyriform capsule, 5-9 (10) mm long, 3-6 mm broad, greenish to tan, smooth, dehiscing apically by 5 valves each bifid into 2 narrow teeth ca. 1 mm long; **seeds** numerous, 0.7-0.9 mm long, brown, orbicular to reniform and prominently tuberculate to papillate, especially on the dorsal surface; **stamens** (9) 10, free; **anthers** elliptical, up to 1 mm long; **filaments** linear, 2.1-3.8 mm long; **perianth** of 2 free

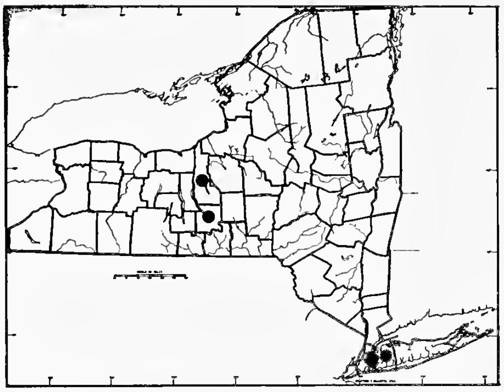
whorls of 5; **petals** white, obovate to narrowly spatulate, 5-11 mm long, 2-3 (4) mm broad; **sepals** ovate to lance-acuminate, greenish to somewhat hyaline, 4-9 (10) mm long, 2-4 mm broad, viscid, glandular- puberulent on the adaxial surfaces; **pedicels** mostly 1-2 (3)cm long, slender, viscid, glandular-pilose, often recurved in fruit; **inflorescences** few-flowered terminal cymes, or flowers borne singly and in pairs in the uppermost axils of leaves and leaf-like **bracts; leaves** with a strong central vein, largely glabrous but viscid- puberulent primarily along margins and lower veins; **upper cauline leaves** 1-5 (8) cm long, 0.5-3.0 (4.5) cm broad, sessile, ovate to broadly lanceolate with acute to acuminate tips, bases obtuse to somewhat cordate, one lobe sometimes larger, inconspicuously clasping, sometimes with winged **petioles** up to a cm long; **lower cauline leaves** up to 9 by 4 cm, often cordate, sometime with winged **petioles; stems** loosely branched, often sprawling, 5-50 (80+) cm long, somewhat ridged and angled, viscid, glandular-pilose to hispid or glabrous, especially those on lower stems in contact with water; **root system** perennial, adventitious at the lower nodes (2n = 20?, 28).

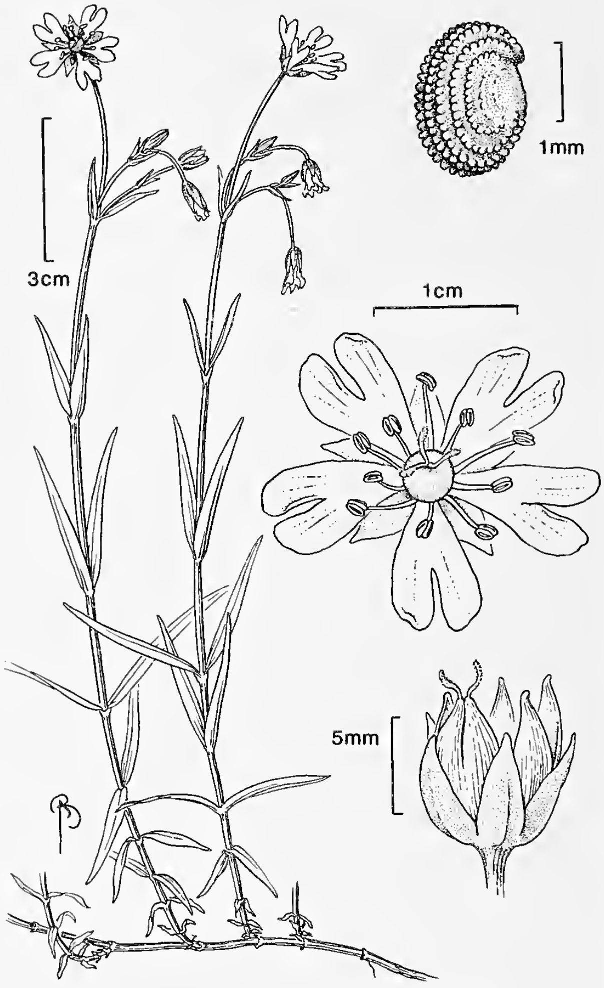
13. STELLARIA

Common Names: Chickweed, Stitchwort, Starwort
Authority: Linnaeus, Species Pl. I, p. 421, 1753
A genus of 100+ species, widespread in open habitats, especially in temperate climates, but also occurring also as weeds almost throughout the world. They are of little value to man except for the widespread species *S. media* (L.) Vill., which is sometimes used in salads and folk medicine.
Description: Plants with **bisexual** flowers; **stigmas** (2) 3 (4-6); **styles** (2) 3 (4-6), free; **ovary** 1, superior; **ovules** many, borne on a free, central placenta; **fruit** a globose to ovoid-cylindric capsule, dehiscent by (4) 6 (8-10) teeth to the middle or near the base; **seeds** many, plump, tuberculate or smooth; **embryo** curved; **stamens** (2-8) 10; **filaments** slender, free; **anthers** globose; **perianth** of 2 free whorls, or the petals may be lacking; **petals** (0-4) 5, deeply bifid for 2/5 their length or more, often white; **sepals** (4) 5, greenish; **pedicels** slender; **bracts** scarious or herbaceous; **inflorescences** dichasial, cymose, or flowers borne singly and in pairs in axils or terminal to main stems and lateral branches; **leaves** paired, ovate to linear, connate-clasping at base; **petioles** lacking (or winged); **stipules** absent; **stems** decumbent, lax to robustly erect; **root system** annual or perennial.

KEY TO SPECIES

1. Flowers often 1 cm in diameter or more; sepals 6-8 (11) mm long . . . . (2)
1. Flowers inconspicuous, usually less than 1 cm broad; sepals mostly less than 6 mm long . . . . (3)
    2. Leaves strap-like, lance-elliptic to linear-lanceolate with acuminate to aristate tips . . . . 1. *S. holostea*
    2. Leaves broadly ovate to elliptic with obtuse to acuminate tips . . . . 2. *S. pubera*
3. Mature cauline leaves 6-30 times as long as broad, sessile . . . . (5)
3. Mature cauline leaves 2-4 (5) times as long as broad, the middle and lower ones often with winged petioles . . . . (4)
    4. Inflorescence bracts membranaceous, hyaline margined; bracts and sepals lanceolate. . . . . 3. *S. alsine*
    4. Inflorescence bracts herbaceous; bracts and sepals elliptic to ovate . . . . 4. *S. media*
5. Flowers borne singly in leaf axils and in few-flowered, terminal cymes; floral bracts herbaceous; petals absent or much-reduced, shorter than the sepals; mature capsules strongly exserted, up to 2-3 times the sepal length . . . . 5. *S. borealis*
5. Flowers borne in terminal or lateral, few to many-flowered cymes; floral bracts scarious; petals shorter to much longer than the sepals (rarely absent); mature capsules usually less than twice the sepal length (6)
    6. Mature capsule slightly to strongly exserted from the calyx, appearing dark, due to pigmented walls or brown seeds visible through the hyaline capsule wall; inflorescence bracts usually glabrous, entire (7)
    6. Mature capsule included or barely exserted from the calyx, pale tan and opaque; most inflorescence bracts with ciliate margins, at least toward the base . . . . 6. *S. graminea*
7. Leaf margins minutely papillose; mature inflorescences (and infructescences) broadly divaricately branched; dehisced capsule greenish-tan to brown, often hyaline, the dark seeds visible within . . . . 7. *S. longifolia*
7. Leaf margins very smooth, pale, not minutely papillose; mature inflorescence (and infructescence) branches ascending; dehisced capsule dark purple-brown to almost black . . . . 8. *S. longipes*





1. *Stellaria holostea* L.

Common Names: Greater Stitchwort, Easter-bell, Great Starwort, Snakegrass, Lady's-lint

Type Description: Linnaeus, Species Pl. I, p. 422, 1753

Synonym: *Alsine holostea* (L.) Britt.

Origin: Native to boreal Eurasia

Habitats: Sandy roadsides and limy woods (in New York)

Habit: Ascending, perennial, rhizomatous herbs

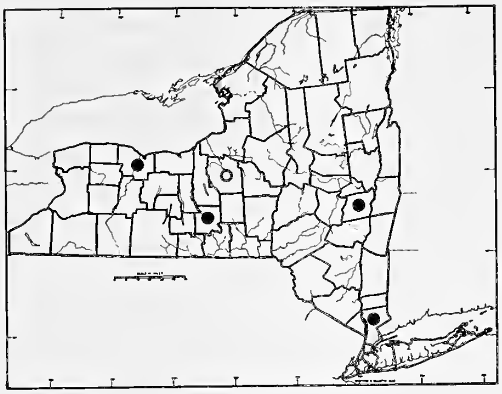
Flowering: (late April) May-June

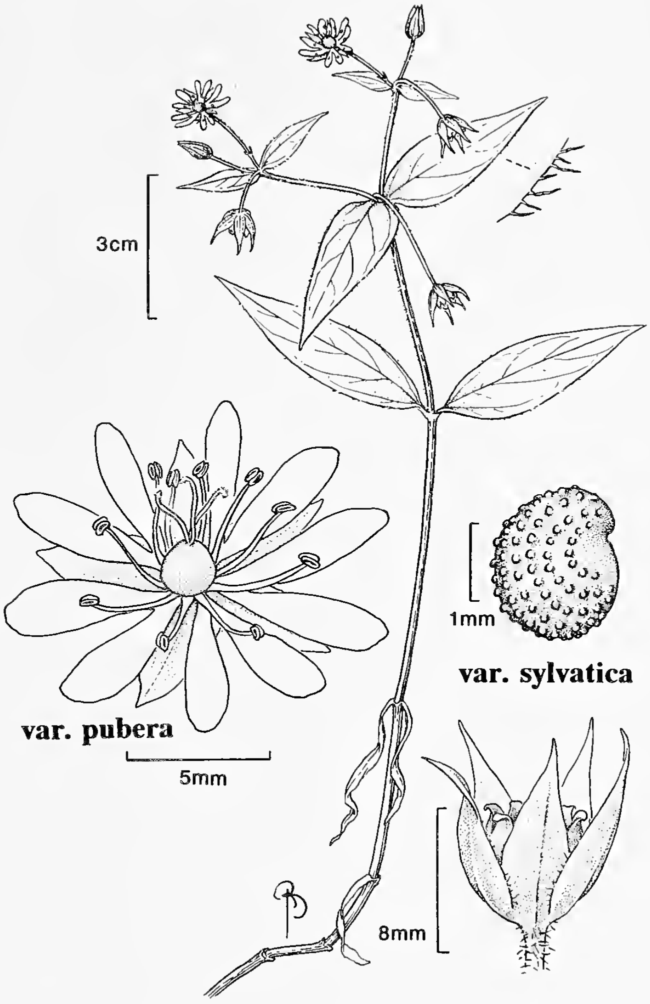
Fruiting: June-July

General Distribution: Escaping cultivation in eastern North America, persisting from New Brunswick to West Virginia; also moderately weedy in its native Europe, the Near East and North Africa

Description: Plants with **bisexual** flowers; **stigmas** 3, papillose, linear near the style tips; **styles** 3, linear, 2.5-3.2 mm long, free to base; **ovary** 1, superior, spheroid to oval; **fruit** a capsule, tan, lustrous, opening by 6 teeth, globose, ca. 5-6 mm long and broad; **seeds** many, brown, 1.8-2.3 mm broad, dolabriform to reniform, with 2 papillose, dorsal ridges; **stamens** 8-10, free; **anthers** golden, elliptic, 0.5-1.1 mm long; **filaments** 4-6 mm long, linear; **perianth** of 2 free whorls of 5; **petals** 8-12 (17) mm long, 3-5 (8) mm broad, showy, white, bifid from 2/5-3/5 their lengths into broadly rounded lobes; **sepals** elliptic-lanceolate with acute, acuminate (or apiculate) tips and rounded cup-like bases, 5-8 (9) mm long, glabrous, greenish with entire, hyaline margins; **pedicels** slender, somewhat angled, scabrescent, up to 2.8 cm long; **inflorescences** terminal and subterminal, few-flowered cymes; **bracts** herbaceous, 2-12 mm long, lanceolate, scabrous along lower margins; **leaves** (1) 2-5 (8) cm long, 2-8 mm broad linear to lanceolate (elliptic-lanceolate) with acuminate to aristate tips, not conspicuously clasping at the sessile bases, mostly glabrous on the surfaces, but rough-scabrous on the margins and lower midrib; **petioles** absent; **stipules** absent; **stems** weakly to strongly ascending, with scabrous ridges, 10-40 (80) cm long at the time of flowering; **rhizome** slender, jointed, with slightly swollen nodes, sometimes bearing minute, fusiform, pinkish **buds**; **root system** slender, largely adventitious at the rhizome nodes (2n = 26).

Importance: This is one of the few chickweeds showy enough to be grown as a garden perennial. They are occasionally used as early-blooming rock garden plants, with flowers up to three centimeters broad.



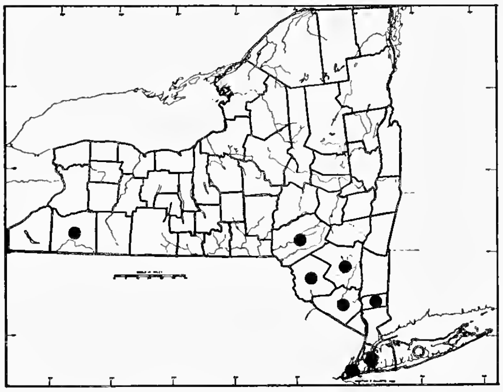


2. *Stellaria pubera* Michx.
Common Names: Great Chickweed, Star Chickweed
Type Description: Michaux, Fl. Bor. Am., vol. 1, p. 273, 1803
Synonyms: *Alsine pubera* (Michx.) Britton (see additional synonymy under varieties)
Origin: Native to Appalachian North America
Habitats: Cool woodlands and open, disturbed places in New York, where it is a rare weed
Habit: Ascending perennials with relatively short flowering shoots in spring, followed by taller, primarily vegetative stems
Flowering: (April) May-June
Fruiting: June-July
General Distribution: Connecticut and New York State as a rare adventive; **Native:** New York? (New Jersey) Pennsylvania, Illinois, south to Tennessee, Alabama, Georgia, North Florida
Description: Plants with **bisexual** flowers; **stigmas** 3, papillose the style tips; **styles** 3, linear, 2.5-3.3 mm long; **ovary** globose; **fruit** a tan, lustrous capsule, 3.2-5.5 mm in diameter, opening by 6 teeth that tend to recoil on dehiscence; **seeds** many, 1.6-1.9 mm broad, reniform, pale brown, papillose; **stamens** (8) 10, **anthers** elliptic, golden-brown, ca. 0.5 mm; **filaments** slender, pale, 3-4 mm long; **perianth** of 2 free whorls of 5; **petals** white, cleft 1/2 to 7/8 their length into 2 entire lobes, 5-12 mm long, 2-5 mm broad, shorter than, or exceeding the calyx; **sepals** 4-11 mm long, 1.0-2.8 mm broad, ovate to elliptic lanceolate with rounded bases and bluntly acute to strongly acuminate tips, greenish with hyaline margins, lustrous, reticulate veined at base, glabrous or villous at abaxial surface near the base and on the **receptacle**; **pedicels** mostly 1-2 cm long, slender, angled, totally villous or with 1-2 bands of villous pubescence; **inflorescences** terminal or subterminal, few-flowered cymes or flowers borne singly or in pairs in the upper axils of primarily vegetative shoots; **bracts** scarious to green, 1-4 mm long, lanceolate, the larger ones ciliate at base; **leaves** ovate to narrowly elliptic-oblong, mostly 1-8 (11) cm long, 0.8-2.5 (3.5) cm broad, pustulose, glabrous except villous on margins and lower midrib, sessile or with winged **petioles** up to 2 cm long; **stipules** absent; **stems** ascending, 5-30 cm tall, 4-angled with villous hairs, particularly on upper stems, flowering early, then producing more vigorous, primarily vegetative shoots up to 40 cm, from a tough, pale **rhizome; root system** fibrous, primarily adventitious from the nodes of the rhizomes.
Infraspecific Variation: Two ploidy levels are known, with features that have lead some students of the group to recognize two species. *Stellaria corei* Shinners is the correct name at the species level for plants with conspicuously attenuate, glabrous sepals and a tendency for the leaves to be petiolate. Plants from near Rochester, New York, however, exhibit distinct petioles and shorter, acute to blunt sepals typical of *S. pubera*, while largely lacking adaxial pubescence. I choose to recognized these taxa at the varietal level.

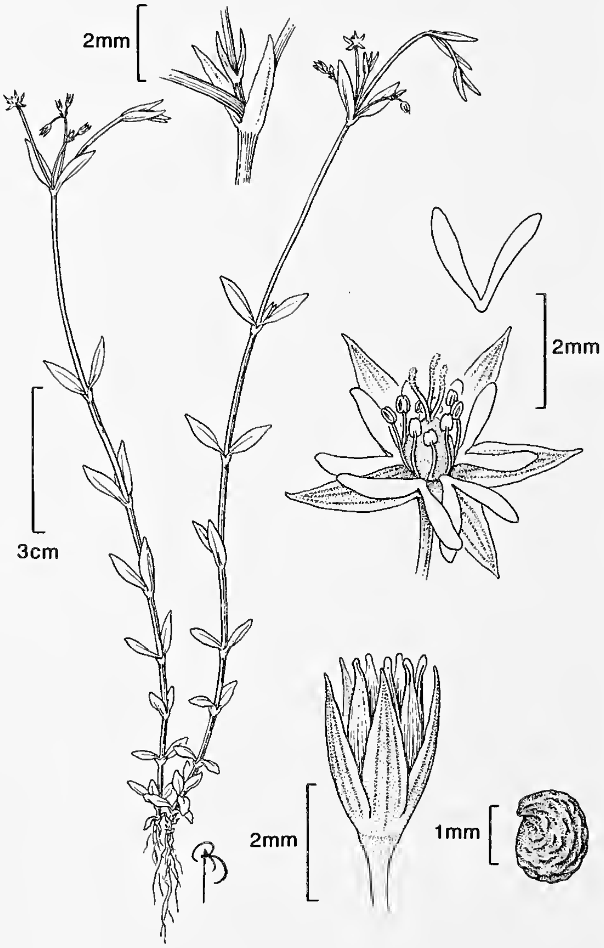
KEY TO VARIETIES

1. Sepals mostly 4-6 mm long, acute to obtuse, often puberulent on the adaxial surface; petioles lacking (or only the 1-3 lowermost leaves with evident petioles) .... 2a. var. *pubera*
1. Sepals mostly 7-10 mm long, conspicuously acuminate, glabrous on the adaxial surface (sometimes puberulent at base); middle and lower leaves often petiolate .... 2b. var. *sylvatica*

2a. *Stellaria pubera* var. *pubera*
Synonyms: *Alsine pubera* var. *tennesseensis* Mohr., *A. tennesseensis* (Mohr.) Small
Origin: Native to the Appalachians of the southeastern United States
Habitats: This diploid variety (2n = 30) is known in New York State from a single specimen from a wooded area near Rochester, where its origin is questionable; although it is well north of its natural range, there is a possibility that it is native in New York State (as in the Chicago area)
2b. *Stellaria pubera* var. *sylvatica* (Bég.) Weatherby
Synonyms: *S. corei* Shinners, *S. sylvatica* (Bég.) Maguire
Origin: Native to the Appalachians and midwestern U. S.
Habitats: This tetraploid variety (2n = 60) has been found both escaped from cultivation and spreading in existing gardens in New York State
Importance: Both varieties of *Stellaria pubera* are occasionally cultivated, but usually south of our range. One specimen of *S. pubera* var. *sylvatica* was collected in an Albany County garden "spreading rapidly."

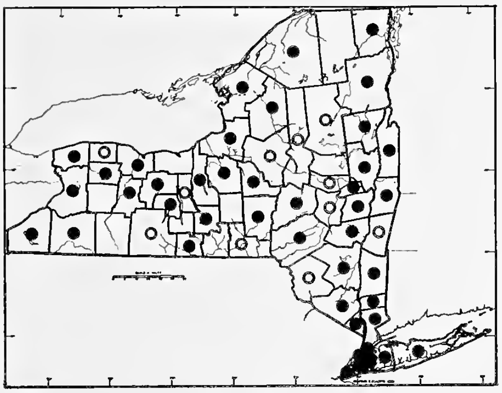


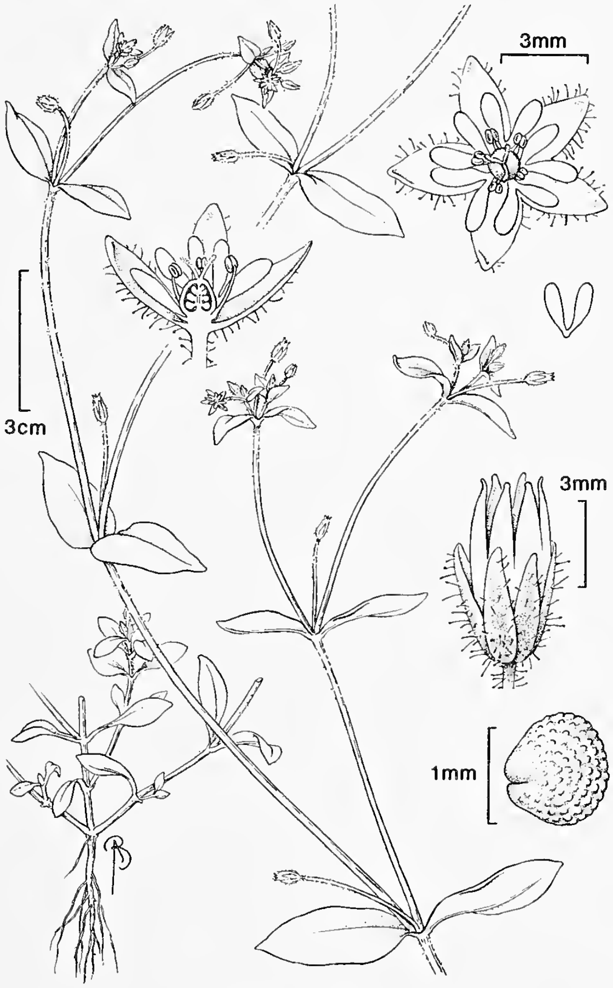
3. *Stellaria alsine* Grimm
Common Names: Marsh Chickweed, Bog Starwort, Stitchwort
Type Description: Grimm, Nova Acta Acad. Leop.-Carol., vol. 3, app: 313, 1767
Synonyms: *Alsine uliginosa* (Murr.) Britt., *S. uliginosa* Murr.
Origin: A native of northern Eurasia
Habitats: Moist ledges, springs and streambeds as a weed
Habit: Lax, decumbent to ascending annuals or biennials, often sprawling with ascending leaves
Flowering: May-October
Fruiting: May-December
General Distribution: Native of Northern Eurasia that occurs sporadically as a weed from Newfoundland to Maryland (Tennessee), Minnesota, British Columbia and Washington State



Description: Plants with **bisexual** flowers; **stigmas** 3; **styles** 3, linear, ca. 0.5 mm long; **ovary** 1, superior, ovoid; **fruit** an ovoid, greenish to tan capsule 2.0-3.5 mm long, dehiscing by 6 narrow teeth; **seeds** several to many, brown, plump, 0.5-0.8 mm, rugulose with narrow ridge-like protuberances; **stamens** 10, free; **anthers** pale, globose, minute; **filaments** slender, ca. 1.5 cm long; **perianth** of 1 or 2 whorls of 5; **petals** lacking or white, less than 1.5 mm long, sometimes falcate or contorted; **sepals** 1.8-3.3 mm long, lanceolate, with acute to acuminate tips, entire, eciliate, pale greenish with three prominent green veins; **pedicels** mostly 3-5 mm long, slender, glabrous or with a few villous hairs; **inflorescences** primarily lateral, few-flowered cymes or pairs (flowers rarely solitary); **bracts** of the inflorescence lanceolate, 2-3 (4) mm long, scarious with a minute green midrib, entire or occasionally toothed or bifid; **leaves** elliptic to ovate-lanceolate, mature cauline leaves 6-16 (22) mm long, 2-12 mm broad, entire, glabrous or minutely ciliate on margins; **petioles** absent or winged, up to 6 mm long, sometimes with a few villous hairs at the margins; **stipules** absent; **stems** angled, up to 40 cm. long, lax, decumbent-sprawling to ascending; **root system** slender, much branched (2n = 24, 26).

Infraspecific Variation: These plants vary considerably in leaf size and shape, the more robust leaves of some individuals being strongly petioled.





4. *Stellaria media* (L.) Villars

Common Names: Common Chickweed, Satin-flower, Tongue-grass

Type Description: Linnaeus, Species Pl. I, p. 272, 1753

Synonyms: *Alsine media* L., *A. pallida* Dumort., in part, *S. apetala* Bernard., of some authors, not Ucria, *S. media* (L.) Cyrillo, of some authors, *S. media* var. *glaberrima* G. Beck, *S. media* var. *procera* Klett & Richt., *S. neglecta* Weihe in Bluff & Fingerhut, *S. pallida* (Dumort.) Jung., not Piré

Origin: A native of northern Eurasia

Habitats: Waste places, roadsides, cultivated ground, meadows, open woods, borders and lawns

Habit: Matted, sprawling to ascending perennials (or annuals)

Flowering: (All year) April-December in NY

Fruiting: All year

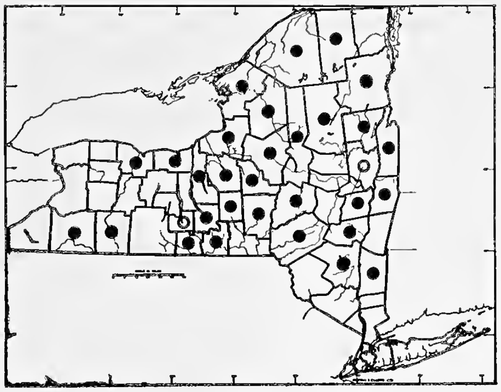
General Distribution: A native of Eurasia and a cosmopolitan weed, especially of cultivated or otherwise disturbed ground

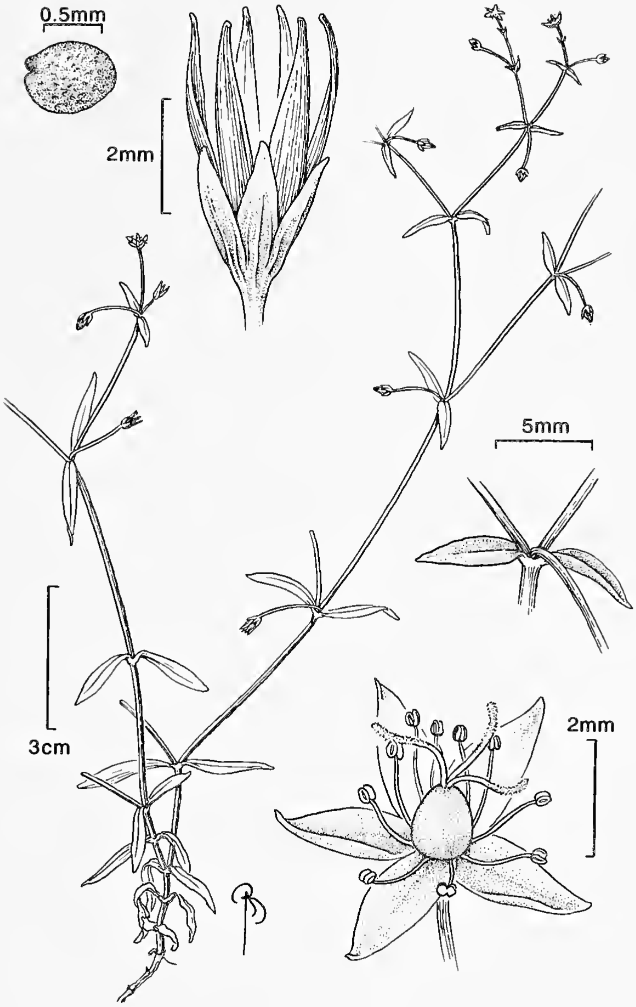
Description: Plants with **bisexual** flowers only or polygamous, with stamens lacking in some flowers; **stigmas** usually 3, papillose along much of the length of the styles; **styles** usually 3, pale, linear, arched outward, 0.5-0.8 mm long, free to base; **ovary** 1, superior, ovoid; **fruit** a somewhat translucent to greenish-tan capsule, 3.0-4.5 (5.5) mm long, 2-3 mm broad, ovate to cylindric, dehiscing by 6 narrow teeth; **seeds** several to many, brown,

0.9-1.5 mm long and broad, reniform, unevenly tuberculate, often prominently on the 2 dorsal ridges, rugulose along the sides; **stamens** free, 2-10 (or absent in some flowers); **anthers** minute; **filaments** slender, pale, 1-2 mm long; **perianth** of 1 or 2 free whorls; **petals** 1-5 (or absent), white, 1-2 (3) mm long, deeply bifid to near the base, the lobes linear to slightly broadened at tips, enclosed or barely surpassing the calyx; **sepals** 5, free, (1) 2-5 (7) mm long, 1-3 mm broad, ovate with obtuse to acute tips, greenish with hyaline margins, pustulose, the adaxial surfaces and margins sparsely to densely villous; **pedicels** 2-20 (27) mm long, villous, at least along one side; **inflorescences** cymose, terminal and lateral with flowers sometime single in the upper leaf axils; **bracts** leafy, similar to the leaves, but some as small as 2 mm long; **leaves** with blades 3-26 (35) mm long, 1-20 (30) mm broad, elliptic to broadly ovate-orbicular, entire with obtuse to acute or apiculate tips and attenuate to broadly rounded bases, upper leaves smaller, sometimes pubescent when young but usually glabrous and merely villous only along the lower margins; **petioles** absent to strongly developed on the larger cauline leaves, up to 2.5 cm, usually with villous margins; **stipules** absent; **stems** angled and grooved, with vertical lines of villous hairs alternating with glabrous channels or entirely villous or, less often glabrous, matted or sprawling up to 50 (90) cm, weakly ascending at tips, bases weak, horizontal or vertical, often persisting over winter in association with a pale, finely fibrous **root system** [2n = 40, 42, 44 (18, 22)].

Infraspecific Variation: This is a member of a polymorphic group that has been split into several species and subspecies in its native Eurasia on the basis of stem and leaf pubescence and sizes of sepals, petals and seeds. The two diploids (2n = 22) from which *Stellaria media* was possibly derived are recognized at the species level in Europe as *S. pallida* (Dumort.) Junger and *S. neglecta* Weihe or maintained as varieties of *S. media* (Behnke, 1976; Tutin *et al.*, 1964) This polymorphic species-complex has ploidy variants and a number of morphological combinations that do not consistently correlate with them, *eg.*, plants escaped in Mediterranean climates (as in California) may be relatively succulent with 1-3 petals and stamens.

Importance: Common chickweed is relatively well known as a pot herb. Although reported to have little flavor, it is sometimes boiled with spinach to add bulk. The greens are also steeped with dandelion stalks to produce a somewhat bitter mixture. In folk medicine, chickweed leaves (dried or fresh) have been added to poultices and ointments used for various curative purposes, particularly in treating discomforts of the skin and eyes. Decoctions have been used internally for a number of ailments, from coughs to constipation. There is no evidence of its effectiveness as an "old wives" remedy for obesity. The fourth most widespread species in the world, *S. media* is sometimes a noxious weed of lawns and gardens with a marked resistance to conventional herbicides. It has been widely studied in terms of ecology, embryology, cytology, genetics, ultrastructure and biochemistry, and there is a large and growing list of metabolic end products for the species.





5. *Stellaria borealis* Bigelow

Common Names: Northern Starwort or Stitchwort

Type Description: Bigelow, Fl. Bost. ed. 2, p. 182, 1824

Synonyms: *Alsine borealis* (Bigel.) Britt., *Bigelowia montana* Raf., *S. calycantha* of NY reports, not (Ledeb.) Bong. (including Fernald's varieties)

Origin: Circumboreal and subarctic

Habitats: Mossy alpine talus, seeps and stream beds; cold, wet forests, marshes, sphagnum bogs, fens and shores

Habit: Creeping to strongly ascending, stoloniferous, perennial herbs (sometimes cespitose in Eurasia)

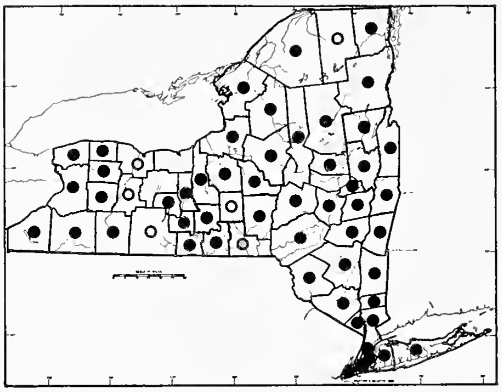
Flowering: June-August

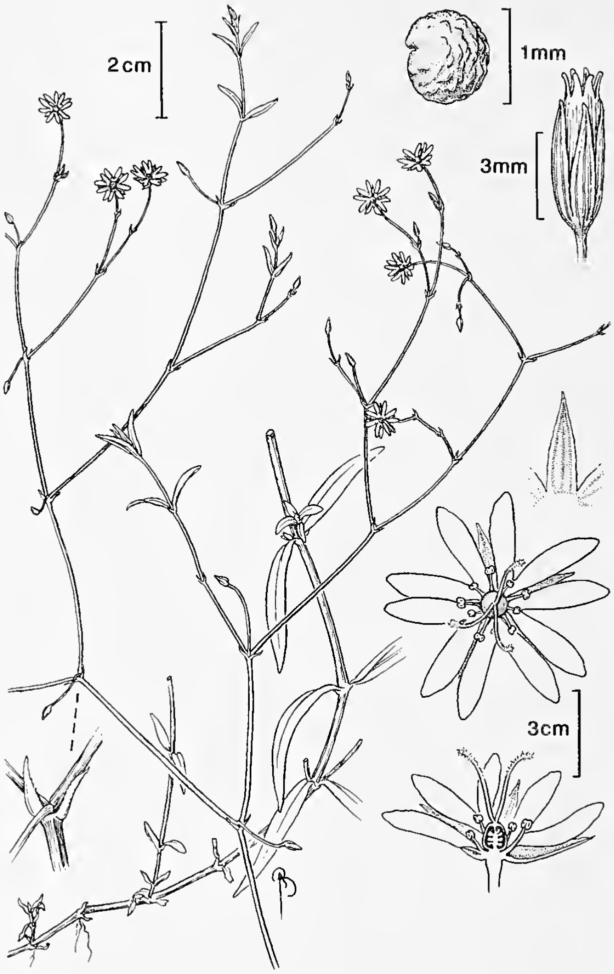
Fruiting: July-September

General Distribution: Greenland to Alaska (Eurasia) south to California, Utah, Pennsylvania and West Virginia

Description: Plants with **bisexual** flowers; **stigmas** 3 or 5 (4,6) papillose lines extending to near the style base from the tips, (which may be bifid); **styles** 3 or 5 (4,6), 1.0-1.4 mm long, filamentous, occasionally with a bifid tip up to 0.5 mm long; **ovary** 1, ovate; **fruit** an ovate to cylindric capsule, 3.1-5.4 (6) mm long, 1.5-3.2 mm broad, dehiscing by 6 narrow teeth 1/2-2/3 its length (or sutures not all equally splitting), surface glossy greenish-tan or purplish-tinted, somewhat hyaline at maturity, appearing darker due to the seeds inside; **seeds** many, plump lenticular, dark brown, minutely rugulose, 0.7-0.9 mm long; **stamens** 6-10, free; **anthers** minute, yellow to reddish, globose; **filaments** slender, 1-2 mm long; **perianth** of 1 or 2 whorls; **petals** absent or up to 5, bifid or only a single lobe, white to translucent, usually less than 1 mm long and not equaling the sepals; **sepals** 1.9-2.8 (4.6) mm long, 0.7-1.4 mm broad, lance-ovate with acute to obtuse tips, pale green with hyaline margins, usually entire; **pedicels** mostly 1-2 cm long, slender, inconspicuously angled and twisted, glabrous, borne singly in the lower leaf axils, and in pairs or small, cymose **inflorescences** at the branch tips; **bracts** leaf-like, herbaceous, as small as 1 mm long, lanceolate to lance-ovate, intergrading with the leaf pairs or with a more abrupt transition when cymose, the margins entire and glabrous or ciliate; **leaves** 0.8-5.5 (7) cm long, 4-8 (11) mm broad, linear to lance-ovate or elliptic with acute to acuminate tips, sheathing obscurely at base, with a strong midrib, surfaces glabrous, margins glabrous, scabrescent or sparsely villous, especially near the leaf bases; **petioles** and **stipules** absent; **stems** lax to strongly ascending, ribbed and channeled, glabrous, from stolons and slender rhizomes; **root system** perennial, primarily adventitious, delicate (2n = 44, 48, 52).

Infraspecific Variation: The plants may appear heterophyllous or homophyllous, depending upon the abruptness of transition between sizes of leaves associated with terminal cymes when they are present. Leaves, and flower parts are somewhat variable in size between individuals and populations. Five described varieties, based on such characters intergrade "insensibly" (Fernald, 1950), and do not deserve recognition.





6. *Stellaria graminea* L.

Common Names: Common Stitchwort, Lesser Stitchwort or Starwort

Type Description: Linnaeus, Species Pl. I, p. 422, 1753

Synonym: *Alsine graminea* (L.) Britt., *S. graminifolia* Salisb., *S. montana* Raf.

Origin: A native of Europe

Habitats: Grassy places, lawns, roadsides, meadows, pastures and streamsides, often in moist soil in full sunlight

Habit: Decumbent, perennial herbs with weakly trailing stems and ascending branch tips

Flowering: May-October

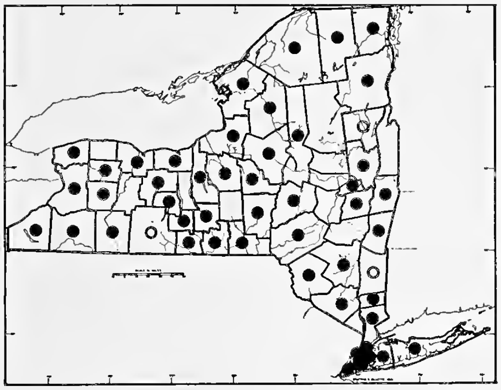
Fruiting: June-December

General Distribution: Newfoundland to Manitoba, south to Missouri and South Carolina; also introduced in Washington, Idaho and California, but less common there; widespread and weedy in its native Europe as well

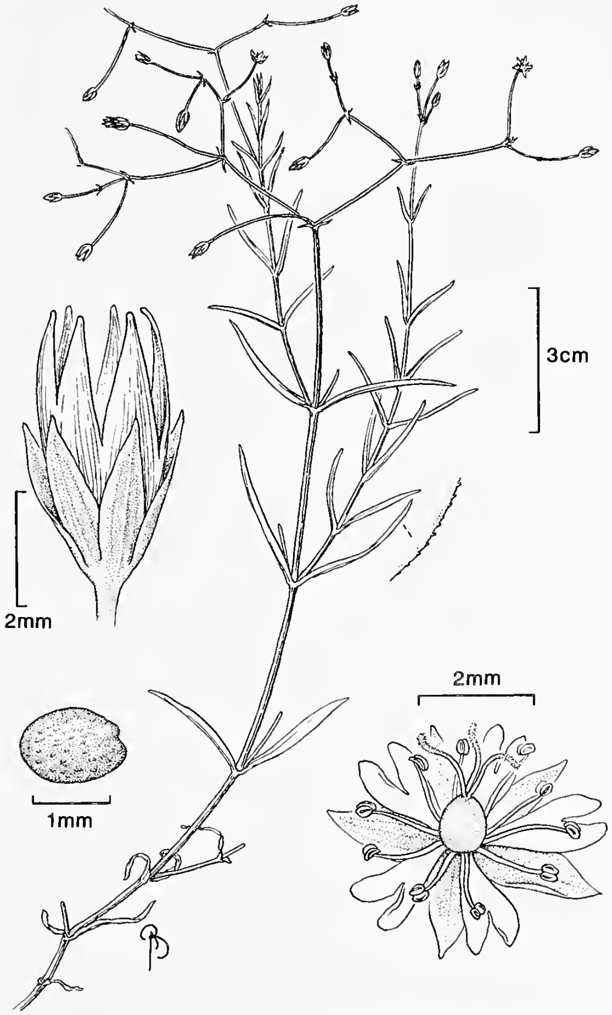
Description: Plants with **bisexual** flowers; **stigmas** 3, each a papillose line, extending ca. 1/3 the style length; **styles** 3, 1.9-2.6 mm long, filamentous; **ovary** 1, ovoid; **fruit** an ovoid to cylindric capsule 3.6-5.3 (6) mm long, 1-3 mm broad with opaque, tan walls, dehiscing apically to ca. 1/2 its length by 6 narrow, blunt-tipped teeth, the tip usually included in the persistent perianth; **seeds** many, 0.7-1.0 (1.2) mm long, plump-lenticular, some with a pronounced dorsal ridge, rugulose to regularly furrowed, red-brown; **stamens** 6-10, free; **anthers** globose, golden; **filaments** slender 4-7 mm long; **perianth** of 2 whorls of 5 (petals rarely absent); **petals** 5 (or fewer, rarely absent), white, usually deeply bifid, 2-6 mm long; **sepals** 5, elliptic-lanceolate to almost linear, with narrowly acute to attenuate (sometimes mucronate) tips, 4.4-7.6 mm long, 1.0-2.6 mm broad, surfaces shiny greenish, 3-nerved, occasionally puberulent below with hyaline margins that are usually ciliate, at least toward the base; **pedicels** slender, glabrous, 0.6-3.0 (4.3) cm long, divergent, often borne at right angles to the axis of the inflorescence at maturity; **inflorescences** primarily terminal, lax, often much-branched, cymes with up to 60 flowers each; **bracts** scarious, lanceolate, mostly 2-4 mm long, nearly always ciliate-margined, at least toward the base; **leaves** (linear to) lance-elliptic, mostly 1-5 (-7.6) cm long, 1-7 (-9) mm broad, midrib strong, surfaces glabrous, but margins usually ciliate, at least near the clasping bases; **petioles** absent; **stipules** absent; **stems** angled and grooved, lax and stoloniferous or sprawling below, somewhat ascending near the tips, usually glabrous, up to 70 (90) cm long; **root system** weak, fibrous, perennial (2n = 26, 39, 52).

Infraspecific Variation: Plants with broader, less grass-like leaves have been called *S. graminea* var. *latifolia* Peterm. in Europe. Young plants are often misidentified as *S. longifolia* Muhl. ex Willd. or *S. longipes* Goldie, but the sharper, star-like sepals, strongly ciliate bracts and more furrowed seeds of *S. graminea* usually allow

correct identification. Three ploidy levels (including sterile triploids) have been recorded in European populations.
Importance: These plants can be noxious weeds of lawns, and they are noticeably resistant to conventional herbicides.

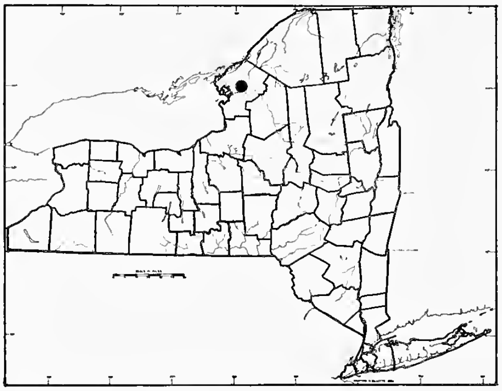


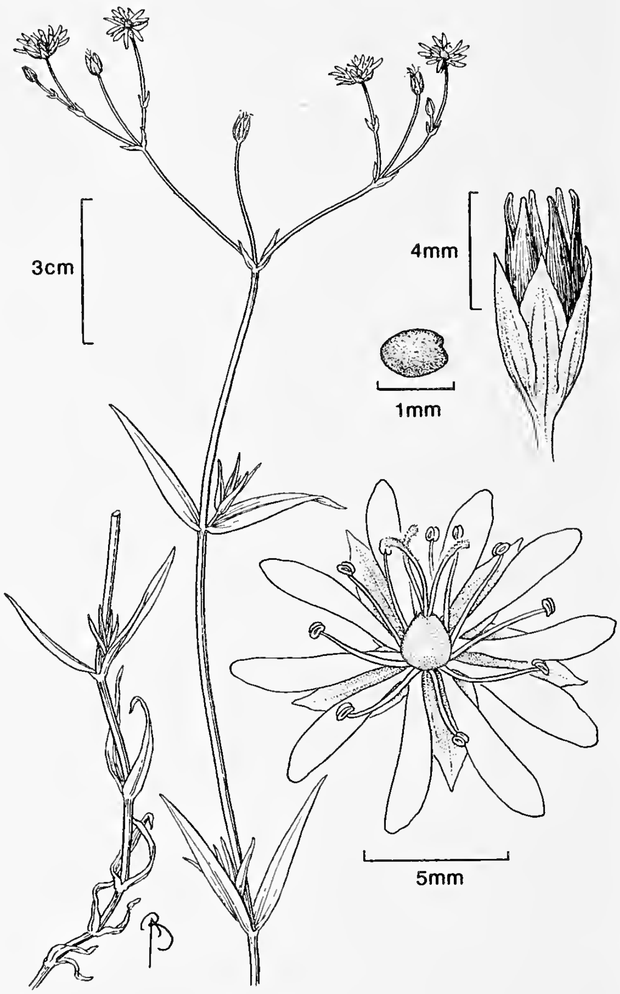
7. *Stellaria longifolia* Muhl. ex Willd.
Common Names: Needle-leaf Starwort
Type Description: Muhlenberg ex Willdenow, Enum. Pl. Hort. Berol., p. 479, 1809
Synonyms: *Alsine longifolia* (Muhl. ex Willd.) Britt., *S. friesiana* Ser. ex DC., *S. longipes* var. *laeta* (Richardson) S. Wats., *S. tenella* Raf.
Origin: Circumboreal
Habitats: Seepage areas and moist soils of meadows, swamps, open forests, thickets; also vernally moist talus, pavement barrens and ditches
Habit: Lax to ascending perennials from a branching rhizome systems
Flowering: May-July
Fruiting: May-September
General Distribution: Circumboreal: in North America from Newfoundland to Alaska, south to New Mexico, Missouri and Tennessee



Description: Plants with **bisexual** flowers; **stigmas** 3, each a papillose line from the style tip to ca. 1/2 its length; **styles** 3, 1-2 mm long, linear, free; **ovary** 1, ovoid; **fruit** an ovoid to narrowly cylindric capsule, 3.8-4.9 mm long, 1.5-2.7 mm broad, glossy greenish to tan (brown), often hyaline before dehiscence, the dark seeds visible through the fruit walls; **seeds** numerous, ca. 0.8 mm long, plump to lenticular with a dorsal ridge, red-brown, rugulose to almost smooth; **stamens** 6-10, free; **anthers** elliptic, golden, minute; **filaments** 2.9-4.1 mm long, extremely slender; **perianth** of 2 free whorls of 5; **petals** 5 (rarely fewer), bifid, white, 2.3-4.8 mm long, shorter to equaling or slightly longer than the sepals; **sepals** 2.6-4.2 mm long, elliptic, with acute to apiculate tips, not strongly veined, glabrous, glaucous green, with hyaline margins that may be ciliate, but usually are not; **pedicels** very slender, glabrous, elongating with age from a few mm (when the flower is in bud) up to 3 (4) cm in fruit; **bracts** lanceolate, usually with eciliate, entire or ragged margins, mostly 1-3 mm long, scarious, but sometimes with a greenish midrib; **inflorescences** lateral, appearing terminal to stems and lateral branches, cymes with their axes ascending at first, but becoming divaricately branched with age; **leaves** 0.7-5.0 (7) cm long, 1-7 (12) mm broad, stiff, ascending, linear to lanceolate (elliptic-lanceolate) with acute tips, or tips appearing acute but minutely blunted, bases clasping, midrib strong, the surfaces usually glaucous and pale green and glabrous, margins revolute, minutely papillose, glabrous or sparsely ciliate toward base; **petioles** absent; **stipules** absent; **stems** glabrous, glaucous, sharply angled and grooved, lax to ascending, up to 50 (80) cm long, 20 cm tall, from slender **rhizomes**; **root system** delicate, mostly adventitious (2n = 26).

Infraspecific Variation & Hybridization: Leaves and stems are sometimes dark green, lacking the typical pale, glaucous sheen; when this is true, however, the plants may be told from the following species by their minutely papillose leaf margins divaricate infructescences and less pigmented capsules. Sepals may be ciliate or not. Artificial triploid hybrids (2n = 39) have been produced through crosses with *S. longipes* (Chinnappa, 1985a), and natural hybrids (also 2n = 39) are reported with *S. borealis* (Morton & Rabeler, 1984).



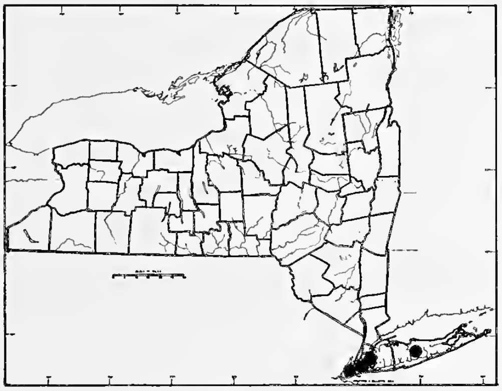


8. *Stellaria longipes* Goldie
Common Names: Starwort, Long-stalked Stitchwort
Type Description: Goldie, Edinb. Phil. Jour., vol. 6, p. 327, 1822
Synonyms: *Alsine longipes* (Goldie) Cov., *S. crassifolia* S. Wats., not Ehrh.
Origin: Circumboreal
Habitats: Limestone cliffs, ledges, shallow soil over flatrock and calcareous arbor-vitae swamp margins; alvar, grassy slopes and meadows in New York State (elsewhere: clearings in rocky, boreal forests and tundra)
Habit: Sprawling perennial herbs with ascending branch tips
Flowering: May-July
Fruiting: June-August
General Distribution: Circumboreal; Greenland and Quebec to Alaska south to California, Colorado, Michigan and northwestern New York; also native in boreal Eurasia
Description: Plants with **bisexual** flowers; **stigmas** 3, each a papillose line on the upper 2/3 of the style; **styles** 3, slender, free, 2-3 mm long; **ovary** 1, ovoid; **fruit** an ovoid to narrowly cylindric capsule, 5.1-7.6 mm long, 1-4 mm broad, opaque, dark purple-brown to almost black at maturity, strongly exserted, dehiscing by six slender valves, the sutures splitting about 1/2 the length of the capsule (or some adhering) **seeds** many, 0.8-1.2 mm long, plump, oval, without a pronounced dorsal ridge, pale red-brown, delicately sculptured; **stamens** 6-10, free; **anthers** oval, golden, minute; **filaments** slender, ca. 3 mm long, pale; **perianth** of 2 free whorls of 5; **petals** 5 (rarely fewer), white, bifid, 2.3-5.8 (6.5) mm long, equaling or exceeding the sepals; **sepals** 5, 2.8-5.6 (7) mm long, ovate with acute tips (rarely notched), pale, glossy green with hyaline margins, glabrous, entire; **pedicels** very slender, ascending, even in fruit somewhat grooved and twisted, glossy, glabrous, elongating from less than a mm in bud up to 4 cm in maturity; **inflorescences** few-flowered cymes, terminal and at the tips of upper lateral branches, the axes and pedicels ascending (not divaricate); **bracts** scarious, lanceolate, mostly 1-5 mm long; **leaves** leathery, 1-5 (9) cm long, 2-12 mm broad, lanceolate with acute to acuminate tips, the bases clasping, bluish green to dark green with a glossy sheen and glaucousness with a purplish tinge, margins very smooth often swollen into a rim, the cells often hyaline (never papillose); **petioles** absent; **stipules** absent; **stems** lax at base, trailing, then ascending at tips, glabrous, glaucous, grooved and channeled, up to 25 (40)

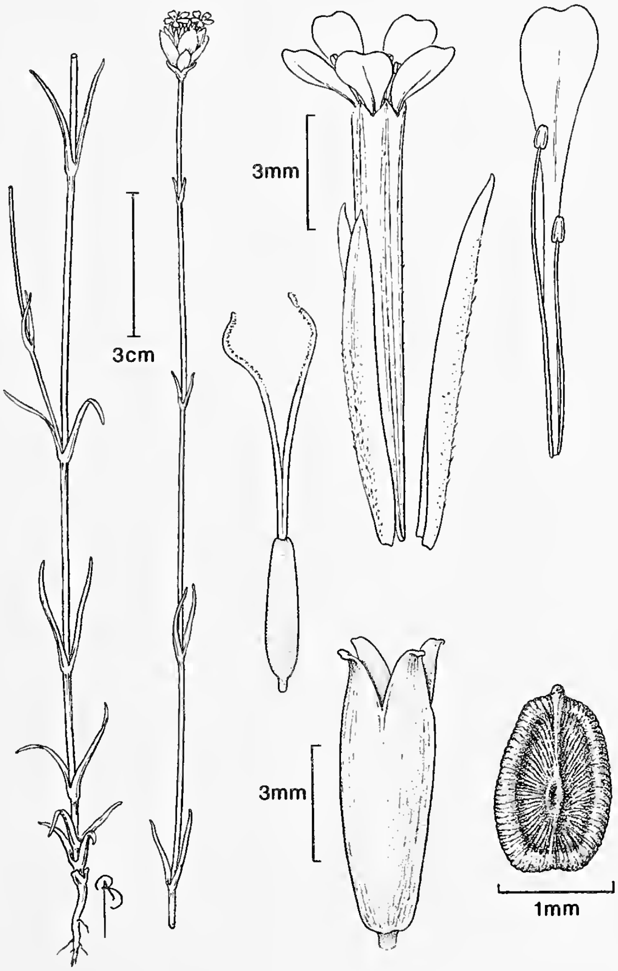
cm long, sometimes reddish toward the bases where they connect to a tough, branching **rhizome** system; **root system** fibrous, largely adventitious at nodes of the rhizomes (2n = 52, 78, 104).
Infraspecific Variation: This taxon has been subdivided into three species Europe. Plants with ciliate sepals and darker capsules have been called *S. ciliatisepala* Trautv., while short plants with more ovate-lanceolate leaves and dense vegetative shoots in the upper axils are called *S. crassipes* Hultén. New York materials sometimes show these characteristics, but they do not segregate in a way that warrants recognition of specific or even infraspecific taxa. Biosystematic studies of North American *S. longipes* (Chinnappa and Morton, 1991, for summary) show a highly polymorphic, phenotypically plastic species with one rare Canadian taxon [var. *arenicola* (Raup) Chinnappa & Morton] deserving recognition at the infraspecific level.
Importance: *Stellaria longipes* is reported to be a forage species for reindeer in Greenland.

14. PETRORHAGIA

Common Names: Childing-pink, Saxifrage-pink
Authority: (Ser. in DC.) Link, Handb. vol. 2, p. 235, 1831
A genus of 25-30 species of herbs with native distributions primarily in the eastern Mediterranean region. Most species have been treated in 20th century manuals under *Tunica* or *Dianthus*, and there has been dispute about the appropriateness of using the generic name *Kohlrauschia* to represent all or part of the group. Some species are cultivated in gardens, and four have escaped and become naturalized in North America.



1. *Petrorhagia prolifera* (L.) Ball & Heyw.
Common Names: Childing Pink
Type Description: Linnaeus, Species Pl. I, p. 410, 1753
Synonyms: *Dianthus carolinianus*, *sensu* Torr. & Gray, not Walt., *D. diminutus* L., *D. prolifer* L., *Kohlrauschia prolifera* (L.) Kunth, *Gypsophila prolifera* (L.) Arcang., *P. prolifer* of authors, *Tunica prolifera* (L.) Scop.
Origin: Native to central and southern Europe and northwestern Africa
Habitats: Dry roadsides and sandy fields
Habit: Erect-ascending, annual herbs
Flowering: May-October
Fruiting: June-December
General Distribution: Scattered and locally adven-- tive: southern New York, western Michigan, Pennsylvania westward to Kentucky and Oklahoma (California), south to North (South)



Carolina, northern Georgia and Alabama (Louisiana)

Description: Plants with **bisexual** flowers; **stigmas** 2, marginal; **styles** 2, linear, ca. 5 mm long; **ovary** 1, superior, ovoid ca. 1.5 mm long, 1 mm broad; **fruit** a slender, oblong to cylindric capsule, tan, smooth, 4-8 mm long, 3-5 mm broad, dehiscing by 4 blunt (or slightly bifid) valves; **seeds** many, oval, 1.1-1.8 mm long, compressed dorsiventrally with an apical tooth and facial hilum, dark brown, the ventral surface papillate, with the appearance of snake skin, finely ridged and fluted dorsally; **stamens** 10; **anthers** elongate, pink or bluish; **filaments** linear, up to 15 mm long; **perianth** of 2 whorls, subtended by imbricate bracts (an epicalyx); **petals** 5, with 1 prominent concolorous central vein, deep or pale pink to bluish (or nearly white), claws 6-12 (14) mm long, limbs flared, 3-5 mm long, obovate to obdeltoid, broadly truncate or emarginate at tips, lacking dark basal coloration; **sepals** fused into a minutely pubescent tube, 6-10 (13) mm long with 5 short, acute calyx lobes, the slender tube greenish with scarious commissures between the veins; **pedicels** lacking; **inflorescence** a terminal, capitate, globose to ovoid head, bearing 2-7 (11) flowers (or flowers solitary); flowers often blooming one at a time, sessile within an **involucre** 4-14 mm long, up to 22 cm broad; flowers subtended by lanceolate **bracts** 4-7 mm long and 1-2 mm broad, the outer involucral bracts broadly to narrowly ovate or obovate, up to 13 mm long, 6 mm broad, the tips obtuse (or mucronate on the outermost bracts), greenish, becoming leathery, stramineous to brown with age; **peduncle** of the inflorescence 2-30 (50) mm long, flexuous, glabrous, ribbed; **leaves** paired, connate at base [sheath 1-2 (-4) mm long], linear to narrowly oblanceolate, 5-25 (40) mm long, 2-4 mm broad, usually 3-veined, the midrib sometimes puberulent, margins variously notched and scabrous; **petioles** absent; **stipules** absent; **stems** solitary, sparsely branched or much branched at base, erect, glabrous to scabrescent, up to 60 cm tall, from a fibrous, annual **root system**, often with a well-developed, erect taproot (2n = 30).

Infraspecific Variation: The plants vary in size, ranging from slender, dwarf individuals with small, few-flowered heads to robust plants 5-6 decimeters tall with 8-10 large basal branches and flowering heads up to 2 cm broad. Plants varying in leaf margin texture and pubescence have been named, but these do not seem to warrant taxonomic rank. Large and small-flowered variants are also questionably distinct (see: Rabeler, 1985; Thomas & Murray, 1981, Thomas 1983), and may represent morphological manifestations linked with the incompletely understood breeding system.

Importance: The larger-flowered race is occasionally cultivated. The flowers are sometimes used to make a tea in Europe, and the extract was used in folk medicine prior to the 17th Century, but the species was often dropped from later herbals.

Note: *Petrorhagia saxifraga* (L.) Ser. ex Link, the saxifrage-pink, is more frequently cultivated than the above species, but it has rarely been reported in New York State as a nonpersistent garden escape. It is a perennial herb that bears solitary flowers (or clusters of 2-3), as opposed to the capitate heads of *P. prolifera*.

15. DIANTHUS

Common Names: Pink, Childing Pink, Sweet-William

Authority: Linnaeus, Species Pl. I, p. 409, 1753

A genus of up to 300 species, depending upon interpretation of taxa at both the generic and specific levels. *Dianthus* species are widely distributed in Eurasia and North Africa, where they usually grow in sunny habitats. The single, native New World species is *D. repens* Willd. of Alaska. Certain species, especially those called "pinks" and "sweet-Williams," are popular in cultivation worldwide. A famous cultivar among *Dianthus* species is *D. caryophyllus* L., the carnation of horticulture. Large-flowered, multi-petaled variants of this plant abound in the commercial cut-flower and pot-plant trade. *Dianthus* x *allwoodii* Hort., is an equally well-known and widely cultivated hybrid of *D. caryophyllus* and *D. plumarius*. There are over 27,000 registered cultivars of *Dianthus* worldwide.

Description: Plants with **bisexual** flowers or **polygamous**, showing some male-sterility; **stigmas** 2; **styles** 2, free or united below; **ovary** 1, superior; **ovules** many, borne on a free-central placenta; **fruit** a unilocular capsule dehiscing by 4 (5) valves, often borne on a carpophore; **seeds** many, flattened or disk shaped; **embryo** scarcely curved; **perisperm** nuclear; **stamens** 10; **filaments** linear; **anthers** often colored like the perianth; **perianth** of 2 whorls subtended by bracts; **petals** 5 (to many in cultivars), clawed, the limb entire or dentate to fimbriate

or laciniate, but not deeply bifid, sometimes bicolored; **sepals** 5, united into a cylindric calyx tube with 30+ nerves, lacking scarious commissures; **bracts** directly subtending the calyx tube in 1-3 imbricate pairs (an epicalyx); **pedicels** slender to fleshy; **inflorescences** panicles or cymes, with flowers in fascicles, glomerate heads, or borne solitary at branch tips; **leaves** paired, entire connate at base, at the conspicuously to only slightly swollen nodes, linear to broad; **petioles** absent; **stipules** absent; **stems** herbaceous to woody, especially near the base; **root systems** perennial (rarely annual or biennial).

KEY TO SPECIES

1. Cauline leaves often more than 1 cm wide, broadly lanceolate; inflorescences dense, showy, corymb-like cymes at the branch tips . . . . 1. *D. barbatus*

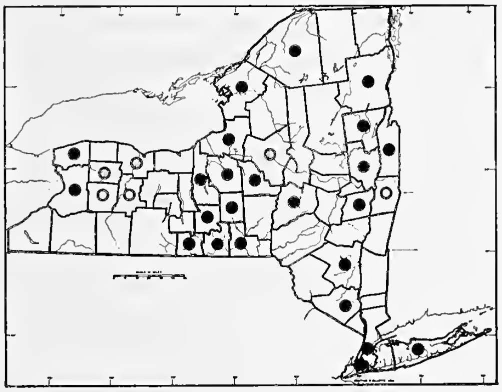
1. Cauline leaves linear to narrowly lanceolate or oblanceolate, less than 1 cm wide; inflorescences of scattered fascicles, open cymes or panicles (or flowers solitary) . . . . (2)

    2. Flowers subsessile, clustered in dense fascicles; epicalyx bracts equalling the calyx tube (or nearly so); taproot present . . . . 2. *D. armeria*

    2. Flowers pedicelled, in open inflorescences or solitary; epicalyx bracts less than half the length of the calyx; roots largely adventitious on rhizomes or stolons . . . . (3)

3. Petal margins ragged-fimbriate, long-fringed; inflorescence few- flowered; stem often solitary from dense, basal tuft of linear-lanceolate, grass-like leaves 2-8 cm long . . . . 3. *D. plumarius*

3. Petal margins merely dentate; inflorescences often many-flowered and borne on multiple stems from much-branched, matted bases; basal leaves oblanceolate, mostly less than 1.5 cm long . . . . 4. *D. deltoides*



1. *Dianthus barbatus* L.

Common Names: Sweet William, Bunch-pink, Sweet-johns, Bloomy-pink, London-pride, French Pink, Snowflake

Type Description: Linnaeus, Species Pl. I., p. 409, 1753

Origin: A native of southern Europe

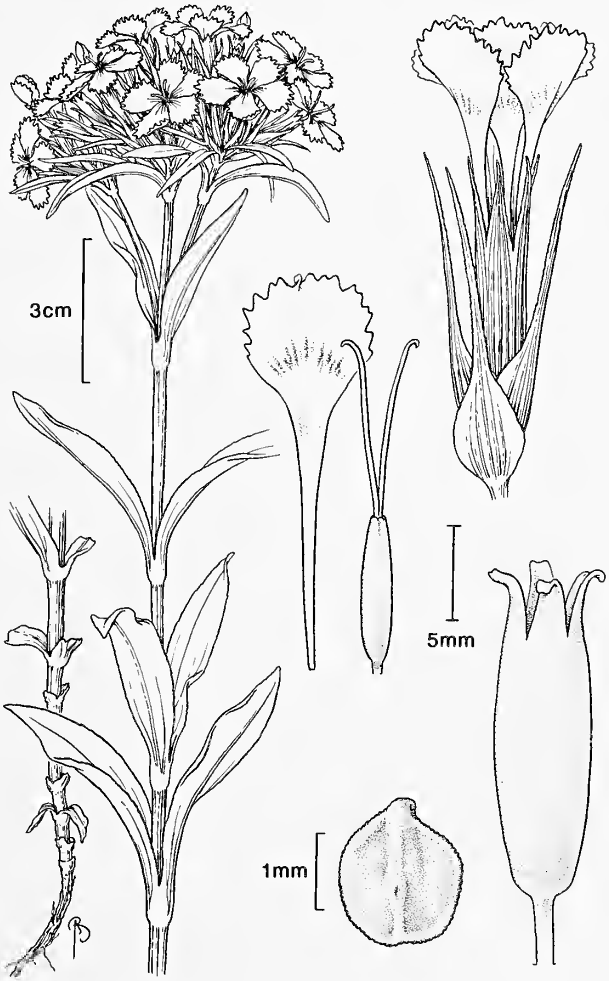
Habitats: Roadsides, cultivated ground, waste places, meadows, woodland clearings and fields, in full sun to partial shade

Habit: Tufted, erect, perennial herbs (sometimes annual or biennial in cultivation)

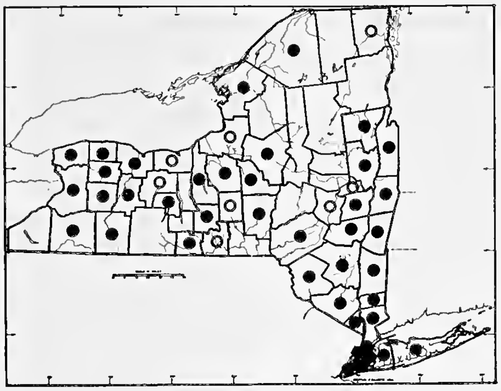
Flowering: June-September

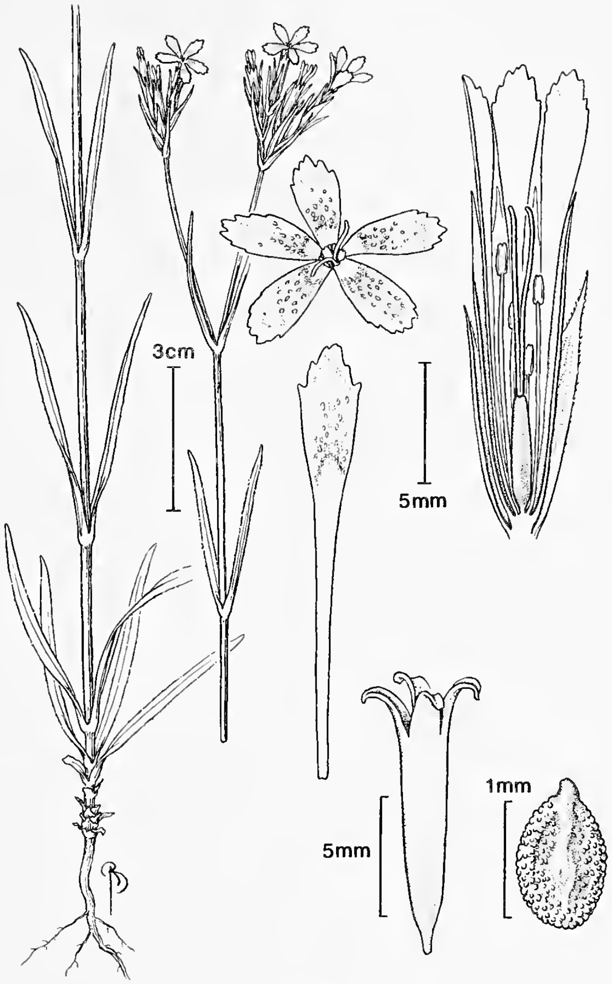
Fruiting: July-October

General Distribution: Widely escaped and naturalized in Eurasia, and in North America from Quebec to British Columbia south to California, the Carolinas, Louisiana and Texas



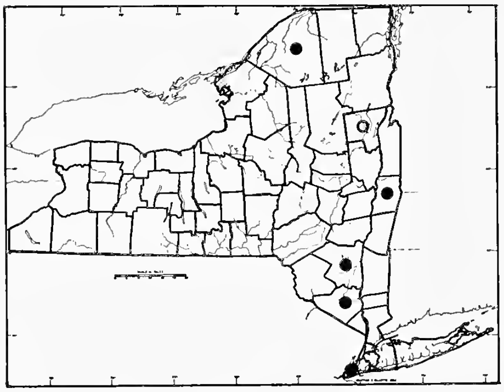
Description: Plants with **bisexual** flowers; **stigmas** marginal, linear, glandular lines extending to near the style bases; **styles** 2, filamentous, pale, 8-12 mm long; **ovary** elliptic, smooth, ca. 3 mm long, on a short gynophore; **fruit** a cylindric capsule, tan, glabrous, 9-12 (15)mm long, 4-5 mm broad, opening by 4 acute (but minutely blunt-tipped) valves, borne on a carpophore up to 4 mm long; **seeds** many, smooth, brown, 2-3 mm long, apiculate, ovoid-deltoid in outline and dorsally flattened; **stamens** 10; **anthers** ca. 1.5 mm long, slender, dorsifixed; **filaments** pale, filamentous, 9-16 mm, varying in length within the same flower; **perianth** of 2 whorls subtended by an epicalyx of imbricate bracts; **petals** distinctly divided into claw and limb, the claw within the calyx tube, pale, linear, 8-14 (17) mm long, ca. 0.5 mm broad, expanded abruptly at the mouth of the calyx into a showy limb, ovate-spatulate to reniform, 7-10 (17) mm broad, the outer margin shallowly and irregularly dentate (bearded), (limb) purple, roseate, pink, white or bicolored, the paler color either interior or exterior to the darker (giving the flower a bull's-eye appearance); **sepals** 5, the lobes pale greenish, sharply attenuate to aristate, 3-6 (9) mm long, united into a cylindric to slightly inflated tube below, 9-20 mm long, 3-8 mm broad, the tube glabrous, shiny, pale green with 30-40+ strong, parallel veins; **epicalyx** bracts up to 2 cm. long, ovate at base with long aristate tips, shorter than the flowers to equaling or slightly surpassing them, greenish or purplish with parallel veins and ciliate to scabrescent margins; **pedicels** 0-7 (11) mm long, ensheathed in the bases of epicalyx bracts; **peduncles** glabrous, bearing the inflorescence fascicles in close proximity; **inflorescence** a showy, corymb-like cyme of densely crowded fascicles of flowers; the primary **bracts** subtending the inflorescence linear-lanceolate, green, glabrous 2-5 cm long, 2-4 mm broad, sheathing at base with ciliate margins; **leaves** broadly lanceolate to oblanceolate, 2.5-7.5 (11) cm long, (0.5) 1-2 (2.4) cm broad, entire, tips acute, surfaces glabrous, scabrescent along the veins and margins, ciliate on the margins of the sheathing bases that may be acute to attenuated, simulating **petioles**; **stipules** absent; **stems** greenish, often somewhat glaucous, ribbed, glabrous, stout near the base (up to 1 cm thick), erect or ascending up to 50 (70) cm, the **nodes** only slightly swollen; plants tufted and spreading by **stolons and rhizomes; root system** fibrous, largely adventitious from the branching, perennial bases (2n = 30, 90).
Infraspecific Variation: European authors have recognized *D. barbatus* ssp. *compactus* (Kit.) Stoj., distinguishing it on the basis of a reddish epicalyx shorter than the flowers and highly attenuated leaf bases. In Europe, flower color is said to be purple, but, in our naturalized plants, flowers often are rosy or white. Other cultivars reported as escapes in New York State include dwarfs and bicolored variants. In the cultivar 'Auriculiflorus' the bases of the petal limbs are auricled.
Importance: A showy garden plant, cultivated around the world in boreal, cool-temperate and Mediterranean climates.

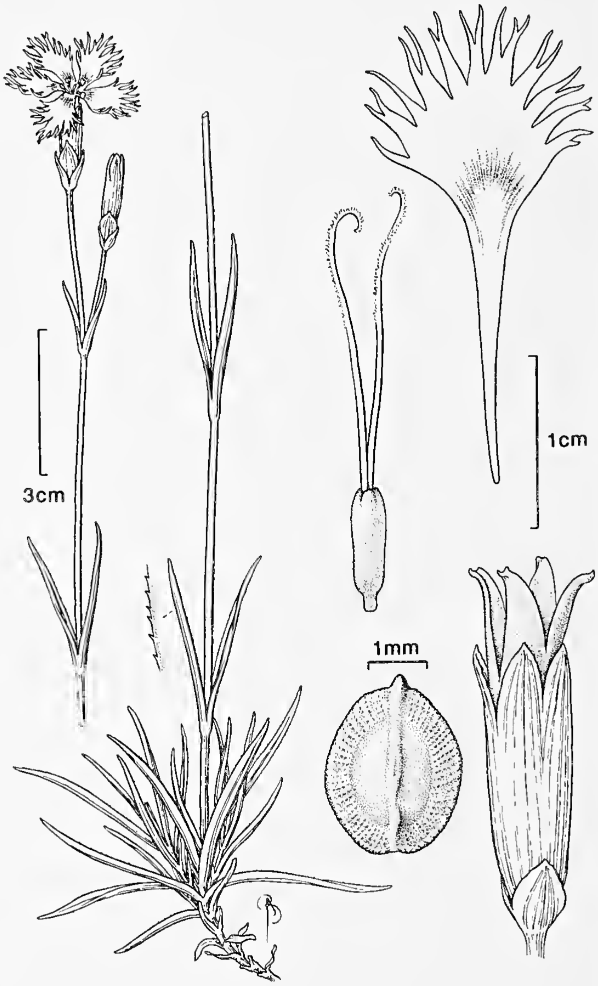




2. *Dianthus armeria* L.
Common Names: Deptford Pink, Grass-pink
Type Description: Linnaeus, Species Pl. I, p. 410, 1753
Synonyms: *D. armeriastrum* Wolfner, *D. epirotus* Halácsy
Origin: Native to temperate and Mediterranean Europe and North Africa
Habitats: Sandy banks, roadsides, fields, dunes and dry soils of waste places and urban environments
Habit: Slender, erect, branching, annual, biennial or weakly perennial herbs
Flowering: June-August
Fruiting: June-September
General Distribution: Widely naturalized: Quebec to British Columbia, south to California and southeast to Georgia
Description: Plants with **bisexual** flowers; **stigmas** marginal, glandular lines extending to near the style bases; **styles** 2, filamentous, 6-9 mm long, exserted from the perianth; **ovary** 1, cylindric, 4-5 mm long, borne on a short gynophore; **fruit** a cylindric capsule 11-16 mm long 2-3 mm broad, smooth, stramineous, opening by 4-5 narrow, terminal valves and borne on a carpophore 1-2 mm long; **seeds** many, 1.1-1.5 mm long, 0.7-0.9 mm broad, apiculate, elliptic, flattened on one side, dark brown, with muricate surfaces; **stamens** 10; **anthers** elongate, dorsifixed, golden or pinkish; **filaments** slender, 8-12 mm long; **perianth** of 2 whorls subtended by an **epicalyx**; **petals** 5, distinctly clawed, the claw within the calyx tube very slender, pale, 10-18 mm long, limb ca. 5 mm long, 3 mm broad, usually shallowly dentate with 2-5 teeth, deep rose to pale pink speckled with white (rarely all white); **sepals** 5, the limbs sharply attenuate with hyaline margins, 3-7 mm long, united below into a slightly inflated, cylindric tube 14-21 mm long, 3-4 mm broad, with 30+ strong ribs, greenish, rosy tinged and mottled, densely minutely villous to almost glabrous; **epicalyx bracts** greenish to red tinged, sometimes with hyaline margins, strongly ribbed, lanceolate to basally expanded and aristate, usually hispid, (5-) 15-21 mm long, sometimes equalling the calyx; **pedicels** 0-6 mm long, ensheathed in bract bases; **inflorescences** densely clustered obconic fascicles, borne terminally and on the upper lateral branches when present (flower rarely solitary with one **epicalyx** bract and 2-4 primary bracts); **primary inflorescence bracts** lanceolate, often equaling and sometimes surpassing the inflorescence length, up to 3.3 cm long, 4 mm broad at base, strongly veined, hispidulous, at least along the margins; **leaves** usually 4-6 pairs per stem, linear to narrowly lanceolate, 1-7 (9) cm long, 0.5-6.5 mm broad, glabrescent to densely short-scabrous, especially along the strong central vein and margins, clasping at base, tips acute to acuminate (or abruptly blunted); **petioles**

absent; **stipules** absent; **stems** erect, up to 90 cm tall, simple or branched upward, slender to stiff and somewhat stout at base, nearly glabrous to scabrescent at the swollen **nodes; root system** usually a biennial taproot with well-developed lateral roots or weakly annual under severe habitat conditions (2n = 30).
Infraspecific Variation: Plants may be robust biennials, annuals or weak perennials, with apparent plasticity in response to soil and microclimatic conditions. The number of inflorescences and lateral branches can also vary strikingly within the same population. Flower color varies in intensity, and white-flowered plants are known in some wild populations.
Importance: These plants are prolific when cultivated in dry, sandy or rocky gardens, and they escape to similar habitats in eastern North America.



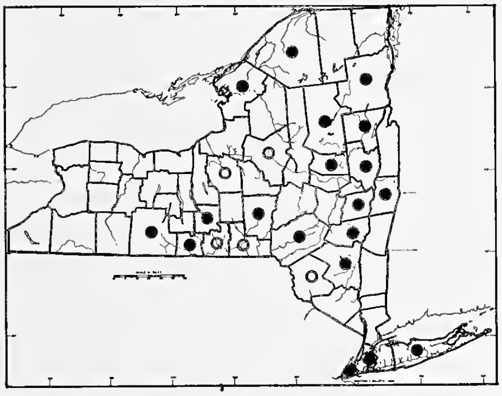


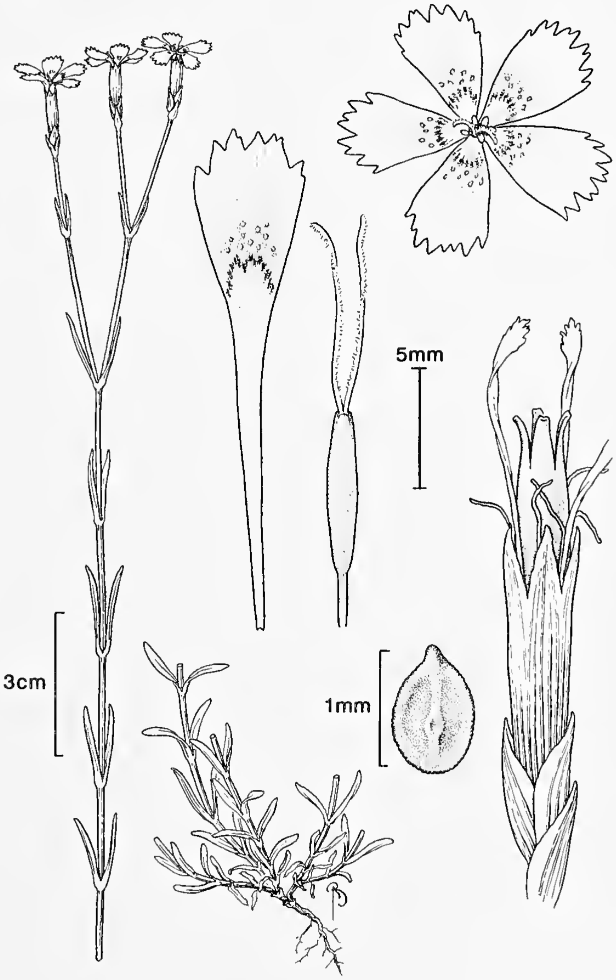
3. *Dianthus plumarius* L.
Common Names: Garden Pink, Grass-pink, Cottage Pink
Type Description: Linnaeus, Species Pl. I, p. 411, 1753
Synonyms: *D. blandus* (Reichenb.) Hayek, *D. hoppei* Portenschl., *D. hungaricus* Pers., *D. lumnitzeri* Weisb., *D. praecox* Kit. ex Willd.
Origin: A native of montane, eastern Europe
Habitats: Grassy banks, sandy roadsides, open, rocky woodlands and clearings (lime tolerant)
Habit: Tufted, rhizomatous perennials with erect flowering stems
Flowering: June-August
Fruiting: June-October
General Distribution: Scattered naturalized populations from occasional garden escapes: Nova Scotia; New England, New York, west to Michigan, Minnesota, Missouri, rarely south to Alabama (North Carolina)
Description: Plants with **bisexual** flowers; **stigmas** marginal, glandular-puberulent lines; **style** 2, sometimes fused near base, linear, 13-21 mm long; **ovary** ovoid-cylindric, 6-8 mm long, borne on a gynophore; **fruit** a cylindric capsule equaling or exserted from the calyx, 1.6-2.6 (3.2) cm long, 4-7 mm broad, smooth, tan, opening by 4 broadly acute to obtuse (minutely blunt-tipped) teeth, borne on a carpophore up to 5 mm long; **seeds** many, ovate-elliptic,, flat on one side, ca. 1.5 mm long brown, muricate; **stamens** 10; **anthers** oblong, dorsifixed; **filaments** linear, up to 22 (30) mm long; **perianth** of 2 whorls subtended by an **epicalyx; petals** distinctly clawed, the claws 12-23 (30) mm long, linear, petal limbs 11-18 mm long (including fringe), 6-13 mm broad, obdeltoid, the outer margin fimbriate-lacerate, the ragged fringe 1/3 to 1/2 the limb length, usually white, red-striated below or deep pink to reddish at the limb bases; **sepals** 5, lobes 3-7 mm long, 1-2 mm broad, obtuse-apiculate, smooth, greenish or pink-tinged with reddish or purplish fringed margins that may be somewhat membranaceous just below the slightly cucullate tip, calyx tube 12-22 (31) mm long, 3-5 mm

broad, glabrous, 40+ ribbed, greeenish, often rosy to purplish-tinged; **epicalyx bracts** 2-6, in pairs that are slightly connate at base, 3-9 mm long, 2-6 mm broad, cucullate-ovate with apiculate tips, pale greenish, ribbed, with reddish (purplish), somewhat membranaceous margins; **pedicels** 3-40 mm long, grooved, smooth; **inflorescence** of 2-3 (5) flowers, borne in the upper leaf axils, or flower terminal, solitary; **cauline leaves** linear, (1) 2-6 (8) cm long, 1-2 mm broad, with a strong midrib and parallel veins, glabrous, greenish to glaucous, somewhat membranaceous near the ciliate to scabrescent margins, tips acute to acuminate, bases, scarious, connate; **basal leaves** densely tufted (grass-like), some pairs remaining short (4-9 mm long and bract-like within the tuft), but most basal leaves linear to linear-lanceolate, 2-8 (12) cm long, 1-2 (3) mm broad, usually with a strong midrib and pseudoparallel veins, margins scabrescent, tips acuminate to subacute, surfaces smooth, green to glaucous, scarious at the connate bases; **petioles** absent; **stipules** absent; **stems** usually solitary, unbranched, from basal tufts of leaves, fluted and ribbed above, 15-30 (45) cm tall; **rhizomes** wiry, dark brown with crowded nodes and scale-like disintegrating leaf bases, 2-4 mm broad, and may be short or up to 4-12 cm long between tufted green shoots, horizontal, but arched upward into a caudex just below the tuft; **root system** fibrous, adventitious (2n = 30, 60, 90).

Infraspecific Variation: A number of cultivated variants have received varietal or horticultural names. These include color forms ranging from rosy to purple and variously bicolored flowers; there are also double-flowered plants with dark green leaves, and a variant with attenuated calyces.

Importance: These plants occurs in the wild as sporadically naturalized escapes from cultivation; they are relatively popular garden plants, known to grow in dry, limy places.





4. *Dianthus deltoides* L.

Common Names: Maiden-pink, Meadow-pink

Type Description: Linnaeus, Species Pl. I, p. 411, 1753

Origin: Native to Northern Europe

Habitats: Dry open places, roadsides, sparse woodlands, vacant lots, meadows, stream banks (lime tolerant)

Habit: Spreading, sometimes matted, rhizomatous perennials with ascending to erect flowering shoots

Flowering: June-August

Fruiting: Late June-October

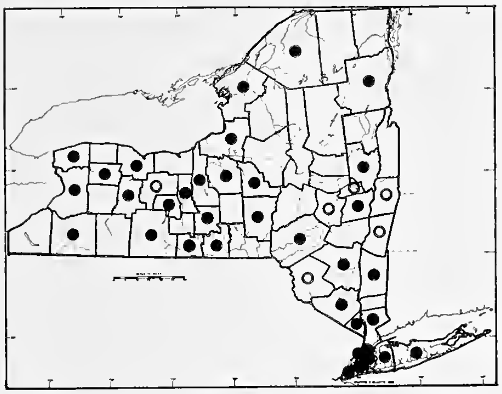
General Distribution: Naturalized from Quebec to Minnesota, Illinois, Virginia, North Carolina and Arkansas; also escaping in Montana and Washington state and probably in other north-temperate regions

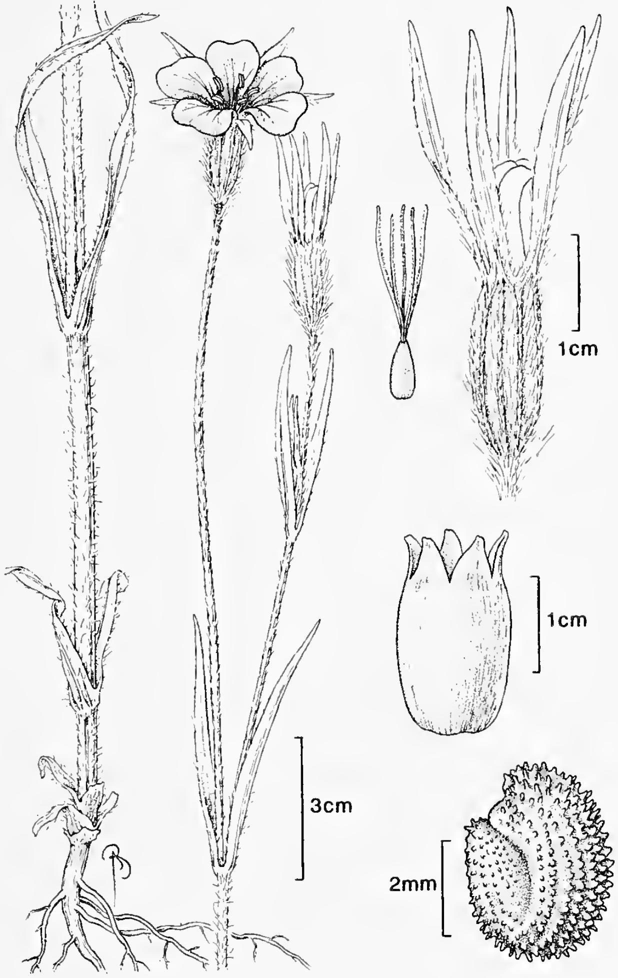
Description: Plants with **bisexual** flowers; **stigmas** marginal glandular lines extending almost to the style bases; **styles** 2, filamentous, 5-7 mm long; **ovary** cylindric, 4-5 mm long, borne on a short gynophore; **fruit** a cylindric

capsule, 14-18 mm long, ca. 2 mm broad, glossy, greenish to tan, opening by 4 (5) narrow, blunt-tipped valves, borne on a carpophore ca. 3 mm long; **seeds** many oval, apiculate, flattened on one side, ca. 1.1 mm long, 0.8 mm broad the surfaces muricate, dark brown to black; **stamens** 10; **anthers** oblong, basifixed; **filaments** slender, 13-18 mm long; **perianth** of 2 whorls subtended by an **epicalyx**; **petals** 5, distinctly divided into claw and limb, the claw 10-19 mm long, pale, slender, but not linear, gradually broader (often more pigmented) toward the apex, the limb deltoid, 5-12 mm long, 4-9 mm broad, the margin shallowly to prominently dentate, usually with 4-7 teeth, deep rose to pink (white spotted) or white, flowers sometimes prominently bicolored with dark purple-rose or white centers and distinct rosy margins; **sepals** 5, the lobes 2-4 mm long, acute, puberulent with ciliate margins, the tube cylindric, 11-15 (18) mm long with 30+ moderately prominent ribs, greenish with pink or deep rosy tint, the surface puberulent; **epicalyx bracts** 2 (-4), pale, pink-tinged, ovate with sharply acuminate to slightly aristate tips, 5-7 mm long, 2-4 mm broad; **pedicels** (0.4) 1-3 (4.7) cm long, scabrescent; **inflorescence** an open, cyme-like panicle, often bearing many flowers on erect, fertile branches, the flowers single on distinct pedicels, but not fascicled; **bracts** at the pedicel bases leaf-like but more membranous, linear, ca. 1 cm long, puberulent; **leaves** dimorphic, those of the creeping vegetative shoots and bases of flowering shoots oblanceolate to spatulate, 2-13 (16) mm long, 0.5-3.2 mm broad, their margins scabrescent, tips obtuse to subacute, cauline leaves of flowering shoots in 4-10 pairs, linear to lanceolate, acute-tipped, 5-30 (38) mm long, 0.3-3.5 mm broad, the strong midrib and margins scabrescent, surfaces somewhat mealy-glaucous, bases shallowly clasping with hyaline, ciliate margins; **petioles** absent; **stipules** absent; **stems** dimorphic, the vegetative branches crowded, wiry, much-branched, creeping to low-bushy; flowering branches erect or ascending, up to 40 (60) cm tall, slender, rarely branched except in the inflorescence, internodes smooth to papillate or scabrescent, nodes not conspicuously swollen; **rhizomes** and **stolons** much-branched, forming wiry clumps; **root system** largely adventitious from the perennial bases (2n = 30).
Infraspecific Variation: Flower color is extremely variable in escaped cultivars, ranging from deep purple-rose to pink or white, often in bicolored combinations.
Importance: These plants are widely cultivated in gardens.

16. AGROSTEMMA

Common Name: Corn Cockle
Authority: Linnaeus, Species Pl. I, p. 435, 1753
A genus of 2-3 species (or monotypic with varieties and races), native to eastern Europe and Asia Minor. The plants are closely related to *Lychnis* but annual. The naturalized representative in North America, *A. githago* L., is a weed of corn and other grain fields, also widespread in Eurasia, where it is an agricultural pest as well. The seeds are poisonous.





1. *Agrostemma githago* L.
Common Names: Corn Cockle, Purple Cockle, Corn-rose, Corn Campion
Type Description: Linnaeus, Species Pl. I., p. 435, 1753
Synonyms: *Lychnis githago* (L.) Scop.
Origin: Native to Mediterranean Europe
Habitats: Corn and wheat fields and other cultivated ground, roadsides pastures and waste places
Habit: Stout, branching, erect or spreading annuals
Flowering: Late May-September
Fruiting: June-November
General Distribution: Newfoundland to Alaska, south to California, eastern Texas and northern Florida
Description: Plants with **bisexual** flowers; **stigmas** linear glandular lines to near the style bases; **styles** (4) 5, linear, 1.0-1.8 (2.1) cm long; **ovary** 1, ovoid, subsessile; **fruit** a stout, ovoid capsule, becoming somewhat woody, smooth and golden on dehiscence by (4) 5 acute (minutely blunted) valves, (the capsule) 14-18 (21) mm long, 8-14 mm broad, subsessile (carpophore absent), enclosed within, and slightly exserted from, the inflated calyx tube; **seeds** many, 2.9-3.4 mm long, ca. 2 mm broad, plump, roughly triangular with 2 flattened sides, dark brown to purple-black, surfaces with prominent, acute tubercles; **stamens** 10; **anthers** linear, basifixed; **filaments** slender, 9-20 mm long; **perianth** of 2 whorls; **petals** 5, showy, the claw creamy to pale pinkish or purplish, 10-14 mm long, 2-3 mm broad, limb bright rose-red to purple, paler toward the base (or white), 10-20 (26) mm long, 7-15 (18) mm broad, the margin retuse, sometimes shallowly dentate to almost entire, limb base without auricles or other appendages; **sepals** 5, the lobes strongly ascending and exceeding the petals, lanceolate, (11) 18-32 (41) mm long, 1.5-3.6 mm broad, with subacute to acuminate tips, strigose to silky-sericeous, the pale trichomes with swollen bases; calyx tube cylindric, somewhat inflated in flower, ovoid and strongly inflated in fruit, enclosing the capsule except at the slightly exserted tip, 11-17 (19) mm long, up to 15 mm broad, with 10 (9-12) broad, greenish veins with sunken, pale, scarious, herbaceous

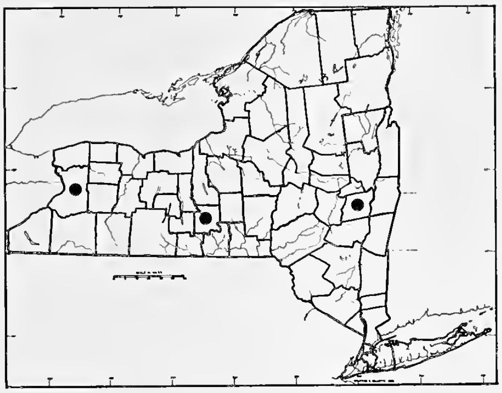
commisures between, silky strigose to pale hispid throughout; **peduncles** 3-15 (26) cm, stout, flexuous, silky; **inflorescence** of singly borne flowers on long peduncles in the upper leaf axils; **leaves** opposite, entire, shallowly connate at base, linear to lanceolate, mostly 6-12 cm long, 2-5 mm broad, silky, appressed strigose to sericeous (or hispid) the trichomes with swollen bases; **petioles** absent; **stipules** absent; **stems** stiff, up to 1 cm in diameter, terete to grooved, erect-ascending up to 1 (1.2) m tall, long-strigose to sericeous; **root system** a tough, annual taproot up to 15 cm long with strong lateral branches and fibrous rootlets ($2n = 48$).
Infraspecific Variation: Flower color varies from purple to rose-pink and white. In the cultivar 'Milas' the flowers are rose-purple and up to 5 cm in diameter. Large- and small-seeded races are reported from Europe where selection has gone on in crop fields (see below).
Taxonomic Note: Plants known as *A. githago* L. are known exclusively as weeds of corn and wheat fields and waste places where they have spread around the world. It has been suggested that this species arose from *A. brachylobum* (Fenl) Hammer (*A. gracilis* Boiss.), a species with a more restricted range in Greece and Turkey. *Agrostemma brachylobum* differs from *A. githago* in having petals longer than the calyx lobes and black spots at the petal bases. Another closely related taxon, *A. linicola* Terechov, is a weed of flax fields, with an earlier blooming period, green-spotted petals and smaller seeds with less prominent tubercles. These weedy variants may be no more than varieties (Hammer *et al.*, 1982) or races selected under the influence of agricultural practices.
Importance: Corn cockle is found less often as an escape from garden cultivation than as a weed of corn, winter wheat, and rye fields. The seeds are poisonous, containing up to 7 per cent of the sapogenin githagenin. They are especially toxic when ground or chewed, causing gastroenteritis, vomiting, slow breathing, dizziness, diarrhea, stomach pain, lesions and possible death to humans and certain livestock, such as horses, cattle and poultry (less often pigs). The seeds were once found as severe grain crop contaminants that sometimes caused significant danger and profit losses. Modern screening and sorting methods have largely eliminated those risks, but corn cockle seeds may still be found in dangerous quantities in some ground corn and oat meals. The roots of the plant are also suspect in hog poisoning cases.

17. GYPSOPHILA

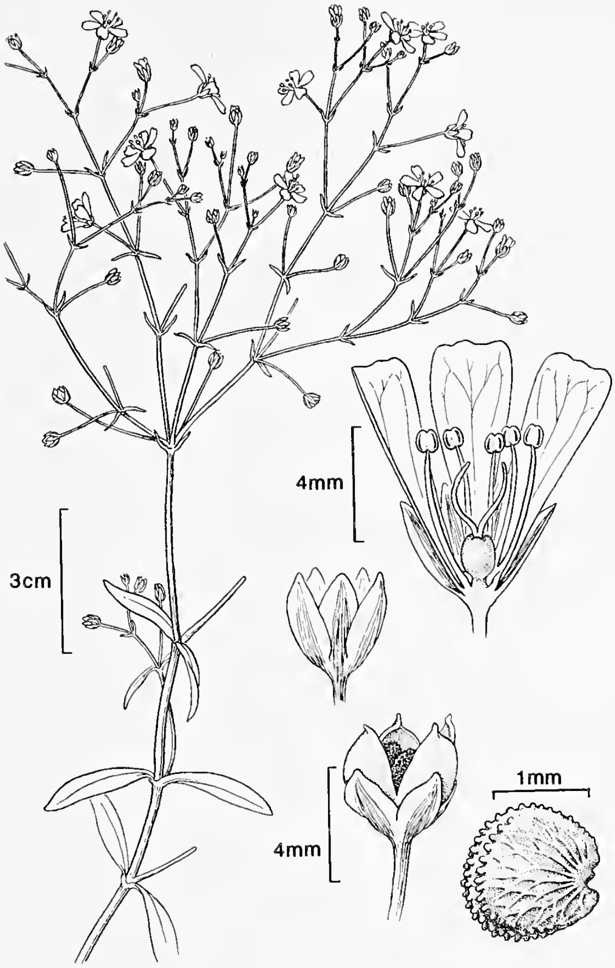
Common Names: Baby's-breath, Gypsophil
Authority: Linnaeus, Species Pl. I, p. 406, 1753
A genus of about 140 species native to Eurasia and North Africa; well represented in the Mediterranean Region. *Gypsophila paniculata* L. and *G. elegans* Bieb. are commonly cultivated under the name "baby's-breath," grown in gardens and greenhouses for use in floral arrangements. These and other *Gypsophila* species are also grown in rock gardens or planted as borders to produce a lacy fringe effect.
Description: Plants with **bisexual** flowers; **stigmas** 2 (3); **styles** 2 (3); **ovary** 1, superior, not stalked; **ovules** many, borne on a free, central placenta; **fruit** a sessile, 1-locular, 4-valved capsule; **seeds** many, subreniform, flattened, rugose to tuberculate; **embryo** peripheral with a prominent radicle; **perisperm** albuminous; **stamens** 10; **filaments** slender, free; **anthers** dorsifixed; **perianth** of 2 whorls, not subtended by an **epicalyx**; **petals** clawed and limbed, lacking coronal scales at the corolla mouth; **sepals** 5 with hyaline margins, united into a turbinate to campanulate calyx tube with veinless commisures; **pedicels** slender; **bracts** many, small; **inflorescence** paniculate, often ubiquitous, corymbiform; **leaves** paired, connate-clasping, entire, linear to broadly strap-like; **petioles** lacking; **stipules** lacking; **stems** often much-branched upward; **root system** woody, perennial, or an annual taproot.

KEY TO SPECIES

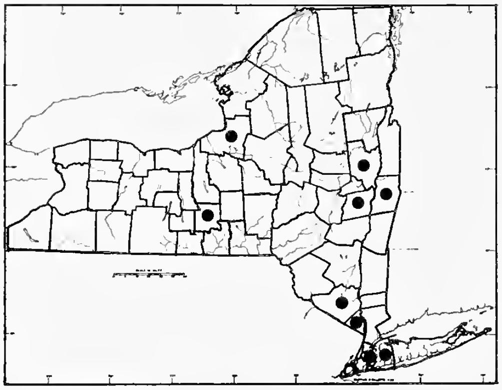
1. Petals showy, 7-12 mm long, often 3-5 times the length of the calyx tube . . . . 1. *G. elegans*
1. Petals usually 6 mm long or less, equaling to about twice the length of the calyx tube . . . . (2)
    2. Lower cauline leaves needle-like, usually 10 mm long, 1 mm broad or less; stem delicate, capillary, from a slender, annual taproot; capsules ovoid to elliptic . . . . 2. *G muralis*
    2. Lower cauline leaves lanceolate, often up to 1 cm broad, 5- 8 cm long; stem slender to stout, from a tough, perennial base; capsules spheroid . . . . 3. *G. paniculata*

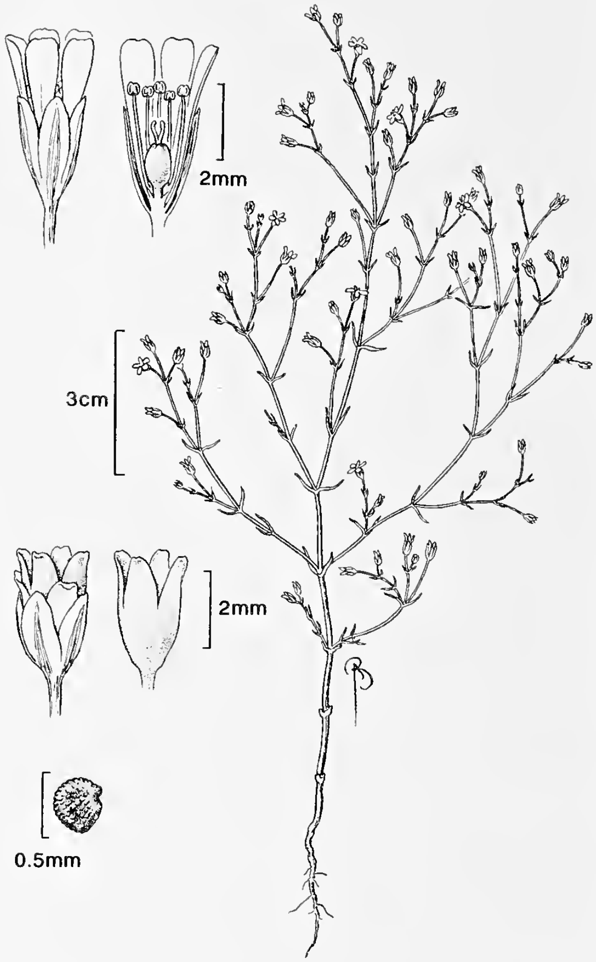


1. ***Gypsophila elegans* Bieb.**
Common Names: Baby's-breath, Tall Gypsophil, Annual Baby's-breath
Type Description: Fl. Taur.-Cauc., vol. 1, p. 319, 1808
Synonyms: *G. carminea* Hort., *G. grandiflora* var. *alba* Hort.
Origin: Native to the Caucasus and montane Asia Minor
Habitats: Roadsides and waste places as an escape
Habit: Erect or ascending annuals with much-branched inflorescences
Flowering: May-September
Fruiting: June-November
General Distribution: Occasionally escaping cultivation and becoming naturalized from southern Labrador to Alberta, New York, western Pennsylvania, Virginia and North Carolina

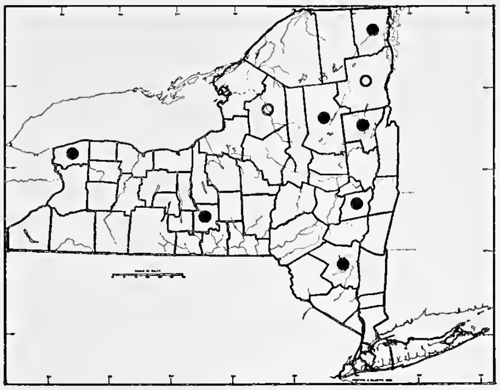


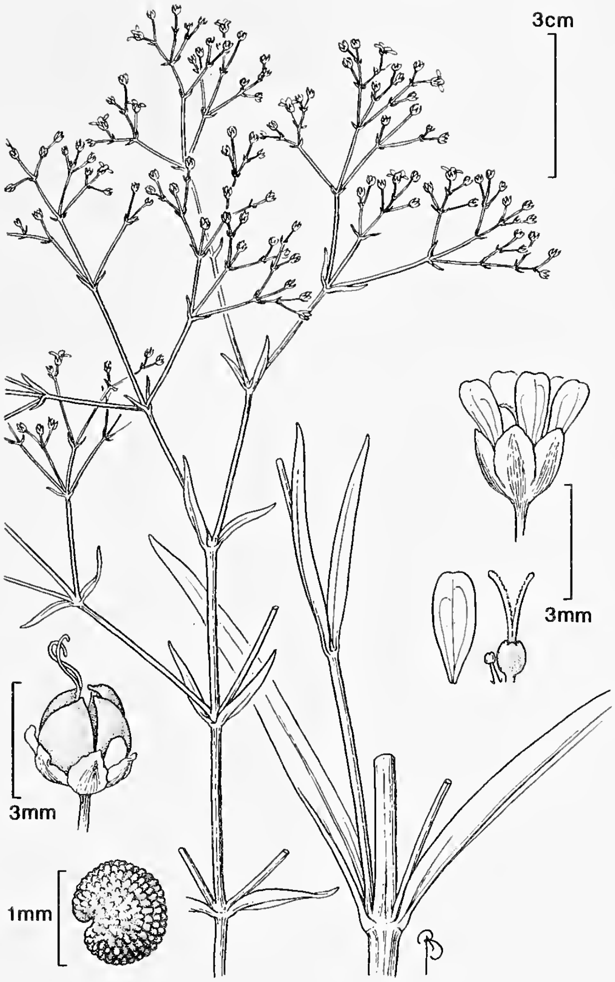
Description: Plants with **bisexual** flowers; **stigmas** 2; **styles** 2, filamentous, ca. 2 mm long; **ovary** spheroid, ca. 1 mm broad; **fruit** a spheroid capsule, 3-4 mm in diameter, opening by 4 broad, obtuse to apiculate valves that split to near the base, surface glossy, tan; **seeds** several, comma-shaped, plump, 1.4-1.6 mm in diameter, dark brown, with a few blunt tubercles, but mostly ridged; **stamens** 10; **anthers** oblong, basifixed, ca. 0.5 mm long; **filaments** thread-like, 3-4 mm long; **perianth** of 2 whorls, lacking an epicalyx; **petals** spatulate, not strongly clawed, (6) 7-12 mm long, up to 6 mm broad, showy, white with purple to rosy veins, and entire margins, unappendaged; **sepals** 5, the lobes 1-3 mm long, obtuse, green in the center with broad scarious to whitish-margins, glabrous, calyx tube shallowly campanulate, 1-2 mm deep; **pedicels** 7-20 (35) mm long, slender, glabrous; **inflorescence** an intricately branched, diffuse, corymb-like panicle up to half the height of the plant; **bracts** paired, 1-10 mm long, linear, glabrous, with hyaline margins toward the base; **cauline leaves** lanceolate to narrowly elliptic with acute to obtuse tips and shallowly clasping bases, somewhat glaucous, entire, with narrow, hyaline margins; **basal leaves** obovate to spatulate; **petioles** absent; **stipules** absent; **stems** smooth, erect or ascending, slightly swollen at the nodes, up to 70 cm tall (including the inflorescence); **root system** an annual taproot, or persisting as a short-lived perennial with fibrous lateral roots (2n = 26, 34).
Infraspecific Variation: Flower color variants include the following cultivars: 'Grandiflora alba,' 'Rosea,' 'Carminea,' and 'Purpurea.'
Importance: This is a relatively popular species in the garden, grown for its show of many dozen of flowers on healthy individuals. It is also cultivated widely for the florist industry. The plants may be purchased in bundles, or, more frequently, they are seen in a variety of floral arrangements, where they provide accents or fringes. The lacy, airy appearance of the inflorescences makes them a favorite in corsages as well. This species may become more widespread in the future, due to inclusion of its seeds in canned wildflower mixes.





2. *Gypsophila muralis* L.
Common Names: Baby's-breath
Type Description: Linnaeus, Species Pl. I., p. 408, 1753
Synonyms: *G. stepposa* Klokov, *G. pilosa* of NY reports, not Huds., *G. porrigens* (L.) Boiss., of NY reports.
Origin: A native of Eurasia
Habitats: Dry roadsides and waste places
Habit: Much-branched, erect annuals
Flowering: July-October
Fruiting: July-December
General Distribution: Occasionally escaped and naturalized: Quebec to Wisconsin (Minnesota), New Jersey and southeastern Pennsylvania
Description: Plants with **bisexual** flowers; **stigmas** 2; **styles** filamentous, ca. 0.5 mm long; **ovary** ovoid, ca. 1 mm long; **fruit** a capsule, tan, somewhat translucent, glossy, ovoid to narrowly elliptic, 2.9-3.4 mm long, 1.4-1.9 mm broad, opening by 4 acute (minutely blunt), valves that split to about 1/4 the length of the fruit; **seeds** many, plump, comma-shaped, 0.3-0.4 mm long, ebony, the surfaces minutely muricate and bluntly ridged; **stamens** 10; **anthers** minute, basifixed; **filaments** slender, 2-3 mm long; **perianth** of 2 whorls, not subtended by an epicalyx; **petals** 4.0-5.3 (6) mm long, ca. 2 mm broad, spatulate, not strongly clawed, emarginate, pink with darker pink veins (purplish or white); **sepals** 5, the lobes obtuse, 1 mm long or less with green centers and broad, hyaline, ciliate margins, surfaces glabrous, the calyx tube turbinate, 1.6-2.4 (3) mm long; **pedicels** filiform, glabrous or minutely glandular, 4-14 (18) mm long; **bracts** linear-filiform, up to 1 cm long; **inflorescence** a delicately branched, complex panicle, often comprising much of the aerial portion of the plant, bearing up to a hundred or more small, pedicellate flowers; **leaves** capillary to linear-oblanceolate, acute, 6-15 (23) mm long, mostly less than 1 mm broad, glabrous, mealy puberulent or ciliolate along the entire margins, hyaline toward the connate bases; **petioles** absent; **stipules** absent; **stems** slender, wiry, much-branched above, often with only a couple of pairs of cauline leaves before branching into an inflorescence, plants 3-30 (40) cm tall; **root system** a slender, contorted, annual taproot with capillary lateral roots (2n = 34).
Importance: This species is cultivated as a decorative fringe, border plant and annual "filler" between perennials in rock gardens. Although not commercially important in the floral trade, it is sometimes used in bouquets.



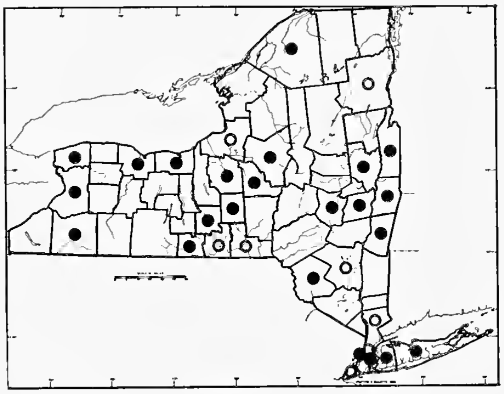


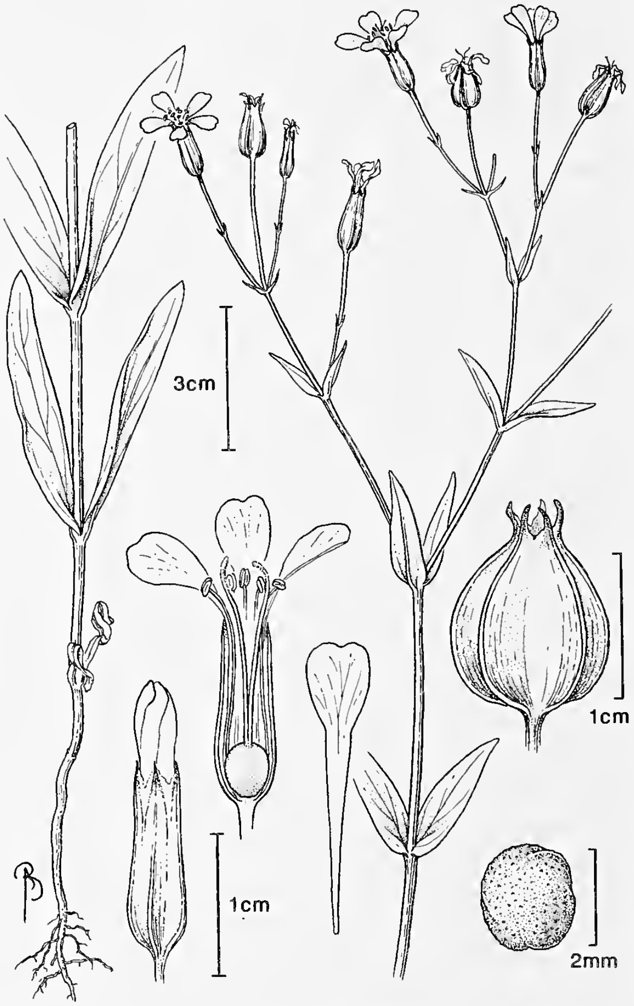
3. *Gypsophila paniculata* L.
Common Names: Baby's-breath
Type Description: Linnaeus, Species Pl. I, p. 407, 1753
Synonyms: *G. bicolor* (Freyn & Sint.) Grossh., *G. paniculata* L. ssp. *bicolor* Freyn & Sint., *G. stevenii* of NY reports, not Fisch.
Origin: A native east-central Europe and central Asia
Habitats: Fields, waste places, meadows, ditches and roadsides
Habit: Erect or ascending, stout, herbaceous perennials
Flowering: June-August
Fruiting: July-October
General Distribution: Occasionally naturalized from Quebec to British Columbia, Washington, Nebraska, Indiana, New England, New York and Pennsylvania (northern Florida)
Description: Plants with **bisexual** flowers; **stigmas** 2; **styles** 2, filiform, ca. 2 mm long, golden; **ovary** spheroid, ca. 1 mm in diameter; **fruit** a capsule, 1.4-2.1 mm in diameter, spheroid, tan, glossy, enclosed within the persistent calyx, opening by 5 obtuse valves; **seeds** several, plump, 0.6-1.1 mm long, dark brown with rounded tubercles and ridges; **stamens** 10; **anthers** minute, globose, golden, dorsifixed; **filaments** pale, filamentous, slightly exserted from the perianth, 3.0-3.5 mm long; **perianth** of 2 whorls, lacking an epicalyx; **petals** 5, 2.4-3.2 mm long, ca. 1.5 mm broad, white, to pinkish or rose, shallowly emarginate, not strongly clawed; **sepals** 5, dark green with broad, scarious, white margins, pale punctate on drying, the lobes 0.6-1.1 mm long, with obtuse tips, calyx tube campanulate, 0.7-1.8 mm deep; **pedicels** 1-9 (13) mm long, very slender, glabrous; **bracts** minute, linear-lanceolate with a green midrib and whitish margins; **inflorescences** multiple, at and near the branch tips, diffuse panicles of corymb-like clusters of minute flowers; **leaves** narrowly to broadly lanceolate, 1-7 (10) cm long, 1-8 (11) mm broad, tips acute (to acuminate) bases of leaf pairs very shallowly connate at the swollen **nodes**, margins entire, leaf surfaces usually glabrous, glaucous; **petioles** absent; **stipules** absent; **stems** up to a meter tall, greenish, glaucous above (rarely pubescent), pale tan with age, up to 1.3 cm broad, suffrutescent toward the base; **rhizome** tough, woody; **root system** adventitious from a perennial rhizome (2n = 34).
Infraspecific Variation: Flower color and size vary from white to pink or reddish between cultivars, and there is a multiple-petaled 'flore-pleno' form. Plants of so-called "ssp. *bicolor*" have larger flowers and broader leaves than is typical.
Importance: This is the common "baby's-breath" of the nursery and cut-flower trade, grown in great quantities and used in corsages and floral arrangements of many kinds. It is also grown in yard plantings, rock gardens and as a border plant where a lacy effect is desired.

Note: A specimen corresponding closely with *Gypsophila arrostii* Guss., as treated in *Flora Europaea* (Tutin, *et al.*, 1964) has been collected in Tompkins County near a plant nursery. It differs from specimens of closely related *G. paniculata* in having dark, glandular pubescence throughout the inflorescence, purple-pink petals, and even blunter, less prominent tubercles on the seeds.

18. VACCARIA

Common Names: Cow-herb, Cow-cockle
Authority: Medic., Phil. Bot. I, p. 96, 1789
A monotypic genus of annual herbs, sometimes included in *Saponaria*. Up to four species have been recognized in the past. Cow-herb is a widespread weed of cultivated fields.





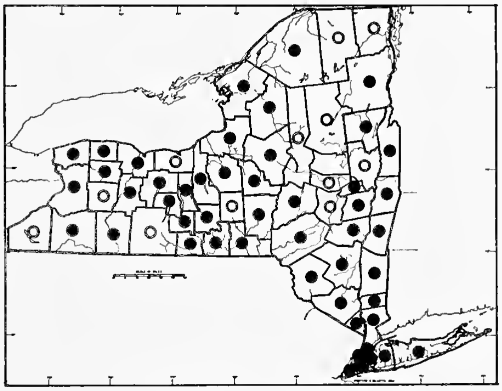
1. *Vaccaria hispanica* (Mill.) Rausch.
Common Names: Cow-cockle, Cow-herb, Cow-basil
Type Description: Miller, Gard. Dict. ed. VIII., 1768
Synonyms: *Saponaria hispanica* Mill., *S. vaccaria* L., *V. pyramidata* Medic., *V. segetalis* (Neck.) Garcke ex Ashers., *V. vaccaria* (L.) Britton, *V. vulgaris* Host
Origin: A native of southern and central Europe
Habitats: Primarily in cultivated fields, but spreading to waste places, sidewalks and roadsides
Habit: Erect, often flat-topped, annual herbs
Flowering: June-September
Fruiting: July-November
General Distribution: Newfoundland to Alaska California and Louisiana (Florida)
Description: Plants with **bisexual** flowers; **stigmas** 2; **styles** 2, filamentous, 8-11 mm long; **ovary** ovoid, subsessile; **fruit** an ovoid capsule, almost filling the persistent, inflated calyx, the capsule tan, smooth, 6-10 mm long, 4-8 mm broad, dehiscing part-way by 4 valves or tearing with age and separation of endocarp from exocarp; **seeds** few to many, red-brown to ebony, spheroid, 2.0-2.7 mm in diameter, the surfaces minutely tubercled; **stamens** 10; **anthers** elliptic, golden, ca. 1 mm long, dorsifixed; **filaments** slender, 8-19 mm long; **perianth** of 2 whorls, lacking a free epicalyx; **petals** 5, claws linear, 8-14 mm long, paler than the limbs, petal limbs 3-9 mm long, 2-5 mm broad, lacking appendages at base, margins entire or emarginate (less often irregular), purplish, or deep rose to pink; **sepals** 5, lobes 1-3 mm long, acute, often purplish with hyaline margins, tube 12-15 mm long, cylindric at first, but soon inflated toward base; (in fruit) the persistent calyx up to 11 mm broad when fully inflated, the tube becoming flask-shaped or pyriform to broadly urceolate with

wing-like ridges, each wing with a strong, cord-like vein at its margin, the green, glossy ridges spanned by paler concavities that are whitish to cream or pinkish-tinged; **pedicels** slender, 6-20 mm long, glabrous, pale greenish to pink-tinged, weakly to strongly ribbed; **inflorescence** a cyme-like panicle or dichasium of few to dozens of flowers, ovoid in outline to conspicuously flat-topped; **bracts** paired, connate at base, ovoid to linear-lanceolate with acute to acuminate tips, 2-10 (18) mm long, green to scarious with a green midrib; **leaves** ovate to obovate or broadly lanceolate, (1) 4-10 (13)cm long, (0.5) 1-4 (4.8) cm broad, tips acute to acuminate (obtuse), bases shallowly clasping, often somewhat auriculate to cordate, surfaces smooth to punctate on drying, margins entire; **petioles** absent; **stipules** absent; **stems** smooth, somewhat glaucous, terete or ribbed, branching above the base, erect, 15-70 cm tall; **root system** a twisted, slender to stout, annual taproot (2n = 30, 60).
Infraspecific Variation: In certain individuals the inflated calyx bears a clear outline of five pale lobes (possibly epicalyx) incorporated into its commissures. Although these structures are totally fused with the calyx structure, their fringed margins may be raised and clearly distinguishable. Flower color varies from purple to rose, brick-red or pink (rarely white).
Importance: Like its relative, the corn-cockle (*Agrostemma*), cow-cockle (*Vaccaria*) is an aggressive invader of cultivated fields in many parts of the world. It competes readily with crops such as linseed flax, significantly decreasing productivity (Alex, 1968). The plants contain dangerous amounts of saponin and githagenin (sapogenin), especially in the fruits, and have been reported to kill both humans and livestock when ingested with grain. Modern screening processes have rendered this threat to humans negligible in commercial products, however, and livestock usually find toxic concentrations of the plants distasteful. Symptoms of githagenin poisoning are shortness of breath, vomiting and dizziness as well as gastroenteritis and lesions in severe cases. The seeds of cow-cockle are rich in starch, but suggestions that it might be grown as a starch crop have not been followed up, partially due to the necessity for extracting the poisonous compounds. Though somewhat showy, *Vaccaria* is not usually valued as a horticultural plant.

19. SAPONARIA

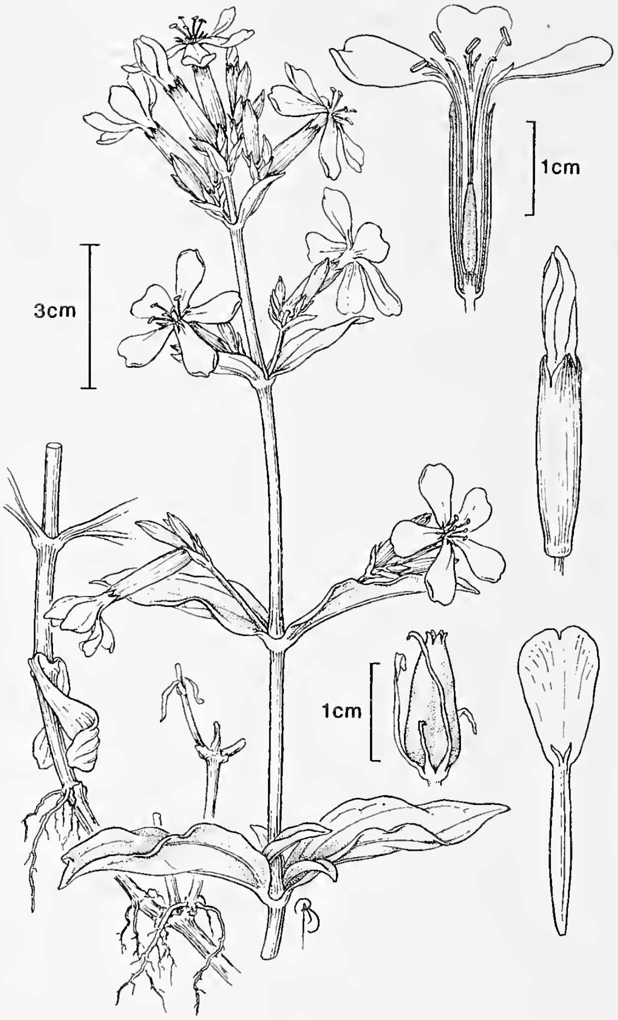
Common Names: Soapwort, Bouncing-Bet
Authority: Linnaeus, Species Pl. I, p. 408, 1753
A genus of about 30 species native to Mediterranean Europe, north Africa and western Asia. Bouncing-bet or soapwort, *S. officinalis* L. is the only species that escapes widely in North America. It is sometimes cultivated in gardens, but it is aggressively competitive with a tough rhizome. The plants were once extracted for a crude soap. Though used in folk medicine in the past, the extract is rich in saponin and other steroid glycosides that should not be ingested in quantity. The seeds are particularly poisonous.

1. *Saponaria officinalis* L.
Common Names: Bouncing-Bet, Soapwort, London-pride, Bruisewort, Fuller's-herb, Sheepweed, Soapwort Gentian, Sweet-Betty, Boston-pink, Old-maid's-Pink, Hedge-pink, Chimney-pink
Type Description: Linnaeus, Species Pl. I, p. 408, 1753
Origin: A native of Eurasia
Habitats: Roadsides, waste places, sidewalks, vacant lots and other urban settings as well as in cultivated fields
Habit: Erect, decumbent or ascending, robust, perennial herbs
Flowering: Late June-September
Fruiting: (June) July-November
General Distribution: Naturalized from cultivation: Newfoundland to British Columbia, Mexico,



Florida and elsewhere; also weedy in Eurasia where it is native

Description: Plants with **bisexual** flowers; **stigmas** 2 (rarely 3), linear; **styles** 2 (rarely 3), filamentous, 16-24 mm long, free or fused just above a short valvate cap; **ovary** ovoid; **fruit** an ellipsoid to cylindric capsule, 12-18 mm long, 2.9-6.8 mm broad, subsessile within the persistent calyx, smooth, tan, opening by 4 (6) narrow valves about 1/3 its length; **seeds** many, comma-shaped, plump, though somewhat compressed, 1.8-2.0 mm long, brown to ebony with muricate surfaces; **stamens** 10; **anthers** ca. 1.5 mm long, golden to pinkish, dorsifixed; **filaments** slender, up to 3 cm long; **perianth** of 2 whorls, not subtended by an epicalyx; **petals** 5, claw 1-20 (26) mm long, ca. 2 mm broad, limb 5-11 (16) mm long, 3-9 (13) mm broad, entire, emarginate or cleft, with a pair of coronal scales 1-2 mm long borne at the at the junction of limb and claw, corolla and fringe white to pink; **sepals** 5, lobes 2-4 mm long, acuminate to caudate, sometimes lacerate, margins with a ciliate fringe, calyx tube 16-21 (27) mm long, 3-7 mm broad, cylindric to slenderly ovoid, greenish, with ca. 20 ribs, not strongly inflated in fruit; **pedicels** glabrous, ribbed, mostly 1-3 mm long; **peduncles** bearing flower clusters mostly 1.5 cm long or less; **inflorescences** dichasial, of congested, cyme-like fascicles, borne terminally and in the upper leaf axils; **bracts** paired, connate at base, lanceolate and acuminate to long-attenuate, mostly 1-4 mm long, the margins sometimes ciliate near the node; **leaves** broadly elliptic or obovate to ovate-lanceolate (2) 5-8 (12) cm long, (1) 2-4 (5) cm broad, margins entire, often minutely revolute and papillose, blade glabrous (to puberulent), with 3 major pseudo-parallel veins arching from the base to near the acute to rounded leaf tip, bases attenuated, often to a **petiole** 2-5 mm long, barely clasping at base; **stipules** absent; **stems** terete, with swollen nodes at which they often bear small, leafy short-shoots, sparsely opposite-branched upward, stalks green to tan or pinkish tinged, erect or ascending up to a meter tall (or nodding), densely colonial from perennial bases; **rhizomes** much-branched, mostly 4-8 mm broad, often arched upward at the plant base into a caudex, with pale, yellowish wood; **root system** finely fibrous, largely adventitious from the nodes of the rhizomes (2n = 14, 28).



Infraspecific Variation: Plants with sterile, multi-petaled, *flore pleno* flowers are not uncommon in the northern parts of their native range in Eurasia and also as escapes in north-temperate North America.

Importance: Bouncing-bet continues to be grown in gardens, but it was once far more widely cultivated. It has perhaps decreased in popularity because of its weediness and association with abandoned lots, back streets and waste places. It is an aggressive, colonial plant, self-propagating from woody, perennial rhizomes, and, in extreme cases, it may become a pest requiring eradication in both urban and agricultural settings. Another common name, "soapwort," comes from the fact that a lather that can be derived by crushing the plants in water. This extract has been used as a soap substitute and a base for homemade and commercial shampoos. The plants have medicinal and folk uses, but the poisonous saponin content has proved dangerous, and demands strict precautions. Europeans and early American settlers used decoctions to treat arthritis, venereal disease, jaundice and a number of other health problems, including external application of poultices for such complaints as itches, warts and bruises. Poisoning and death may result from ingestion of quantities of any portion of the plant, but the seeds are particularly dangerous, since they are richest in saponin and githagenin.

They pose a threat to both humans and livestock, especially if chewed. Symptoms of saponin poisoning include, dizziness, vomiting and shortness of breath, and toxic doses may result in gastroenteritis and lesions as well.

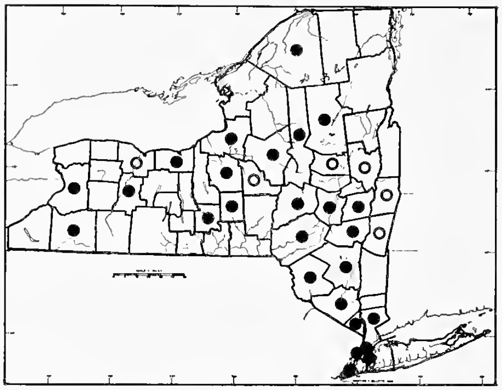
Note: *Saponaria ocymoides* L., the rock soapwort, is a European native that has been found once in New York State, naturalized in a hollow in Ulster County (1967). It has spatulate leaves and bright purplish to pink flowers about a centimeter long, with densely glandular-pubescent calyces.

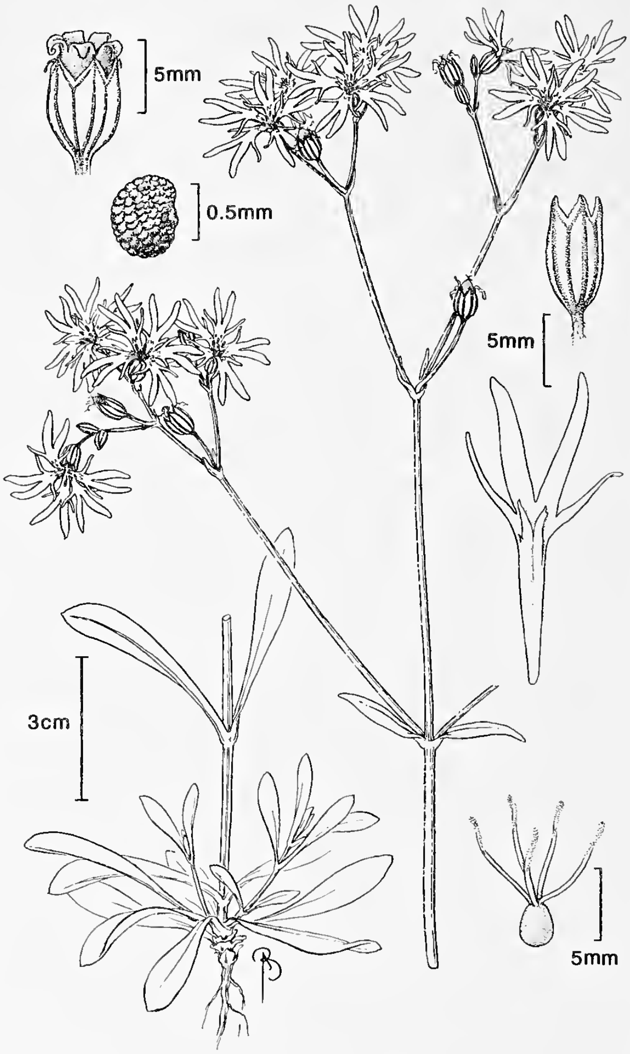
20. LYCHNIS

Common Names: Campion, Lychnis, Pink
Authority: Linnaeus, Species Pl, I, p. 436, 1753
A genus of about 15 species distributed widely in Europe and eastern Asia. Species reported from North Africa and South America are referable to *Silene*. The characters separating *Lychnis* from the closely related genus, *Silene*, have been subject to interpretation, such that some taxa have been transferred back and forth between genera. Certain *Lychnis* species can be quite showy, with scarlet, orange, purple, rose, pink or white flowers, and a number of them have found wide acceptance as garden ornamentals.
Description: Plants with **bisexual** flowers; **stigmas** usually 5; **styles** usually 5; **ovary** 1, gynophore present or absent; **ovules** many; **fruit** a capsule, on a carpophore or subsessile, unilocular or 3-5 septate from the base, dehiscing by 5 acute or bifid valves; **seeds** copious, small, somewhat compressed, muricate or tuberculate; **embryo** curved around the **perisperm; stamens** 10; **anthers** dorsifixed; **filaments** slender; **perianth** of 2 whorls, lacking an epicalyx; **petals** free, white, purple, pink, orange or red, each strongly divided into a limb and claw, usually with a fringe of coronal scales where they join at the corolla mouth; **sepals** 5, united for most of their lengths into a cylindric calyx tube that may become somewhat inflated in fruit; **pedicels** and **peduncles** slender to stout; **inflorescences** variously cymose to paniculate, diffuse to densely clustered; **bracts** paired; **leaves** paired, entire, their bases connate at the node; **petioles** present or absent; **stipules** absent; **stems** erect or ascending from perennial **rhizomes** and fibrous adventitious **root systems**.

KEY TO SPECIES

1. Surface of the calyx tube glabrous; petal margins dissected into linear lobes and teeth; corolla white, pink, purplish or rosy- tinged . . . . 1. *L. flos-cuculi*
1. Surface of the calyx tube sparsely to densely pubescent; petal margins entire, emarginate or deeply bifid, but not dissected; corolla orange, scarlet, or pale red to dark reddish-purple (rarely white) . . . . (2)
    2. Inflorescence a congested cyme, the pedicels less than 0.5 cm long; petal tips conspicuously bifid-notched; plants sparsely pubescent, not silvery-tomentose; mature capsule stalked within the clavate calyx tube . . . . 2. *L. chalcedonica*
    2. Inflorescence not congested, few-flowered, pedicels mostly 2-10 cm long; petals entire to emarginate, but not strongly bifid; plants grayish, often densely woolly-tomentose; capsule subsessile within the obovoid calyx tube . . . . 3. *L. coronaria*





1. *Lychnis flos-cuculi* L.

Common Names: Cuckoo-flower, Ragged Robin, Crowflower, Meadow-pink, Cuckoos, Indian-pink, Ragged-jack

Type Description: Linnaeus, Species Pl., I, p. 436, 1753

Synonyms: *Coronaria flos-cuculi* (L.) A. Braun

Origin: A native of northern and central Europe

Habitats: Roadside depressions, open fields and moist meadows

Habit: Slender, erect-ascending, perennial herbs

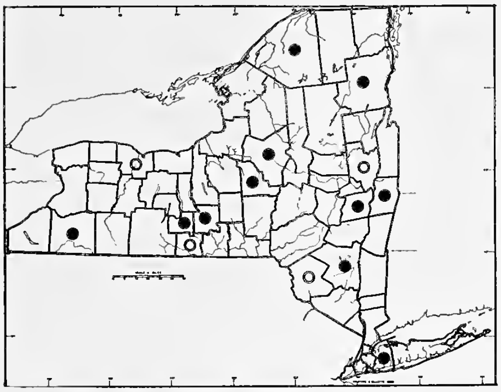
Flowering: May-July

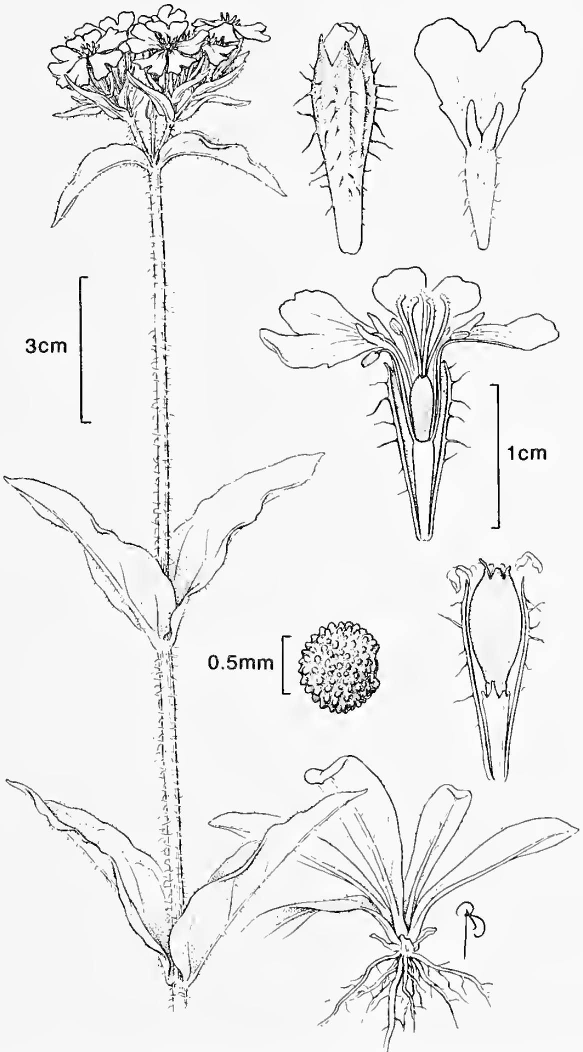
Fruiting: June-September

General Distribution: Escaping cultivation and becoming naturalized from New Brunswick, Nova Scotia and Quebec to New York, New Jersey and Pennsylvania

Description: Plants with **bisexual** flowers; **stigmas** 5; **styles** 5, filamentous, 3-5 mm long; **ovary** ovoid, sessile; **fruit** an ovoid capsule, 6-9 mm long, 4-6 mm broad, subsessile, dehiscing by 5 reflexing valves 2-3 mm long, the surface smooth, greenish to tan; **seeds** many, 0.6-0.8 mm long and broad, somewhat compressed, reniform, the surfaces brown, covered with sharp turbercles; **stamens** 10; **anthers** linear, ca. 1.5 mm long, dorsifixed; **filaments** slender, 6-9 mm long; **perianth** of 2 whorls, not subtended by an epicalyx; **petals** 5, claw slender, often pale, 5-8 mm long, ca. 1 mm broad or less, petal limb 6-10 (13) mm long, bifid, but usually further dissected into linear lobes and teeth for up to 2/3 its length, appendaged at the junction with the claw with 2 slender, bifid or lacerate coronal scales 2-3 mm long, corolla rose, bluish purple or pale pink to white; **sepals** 5, the lobes deltoid, acute to obtuse 2-3 (4) mm long, with copiously ciliate margins, the calyx tube becoming inflated in fruit, 5-8 mm long, 2-7 mm broad, glabrous, glossy, purplish to dark rose, especially along the 10 prominent ribs, often yellow-green or glaucous between them; **pedicels** slender, 1-12 (16) mm long, sparsely woolly-viscid, red-purple; **peduncles** similar, but up to 6 cm, strongly ascending; **inflorescence** often symmetrical, a slender series of 2-4 pairs of upper-axillary and terminal corymbs; **bracts** reddish-purple, linear to lanceolate, mostly 1-6 (13) mm long, with ciliate-fringed margins; **cauline leaves** paired, linear to broadly lanceolate, oblanceolate or spatulate, 1-6 (10) cm long, 1-5 (8) mm broad, margins minutely revolute, glabrous or slightly ciliate on young leaves and those transitional to bracts, tips acuminate to obtuse green, often red or purple tinged, ciliate or bearded at the junctures of the leaf bases that are attenuated into poorly defined **petioles** and barely connate-clasping, **basal leaves** similar to the lower cauline ones, but more obovate to spatulate with (acute) obtuse to rounded tips, up to 14 cm long, 15 mm broad, borne in a cespitose clusters or rosettes, the **petioles** sometimes relatively well-defined, up to 4 cm long; **stipules** absent; **stems** terete to strongly ridged and furrowed, puberulent, especially on the upper nodes, erect, up to 70 cm tall, little branched

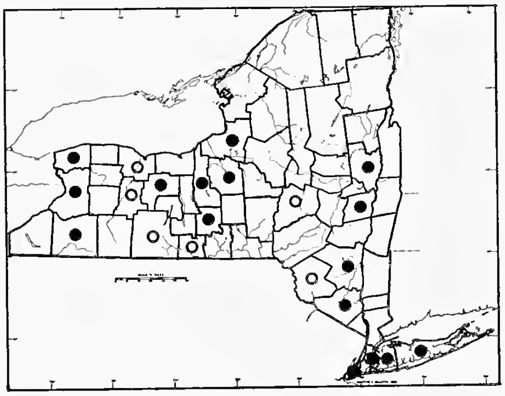
above, but proliferating by densely branching basal shoots and **rhizomes**; **root system** soft-fibrous, matted, adventitious (2n = 24).
Infraspecific Variation: *Lychnis flos-cuculi* ssp. *subintegra* Hayek was described from the Balkan Peninsula, with bifid-emarginate (but uncut) lobe tips. Such plants have not been recorded as naturalized in New York State.
Importance: This is a popular garden ornamental, planted in sunny places in relatively moist, northern climates. Its spread as a weed was largely coincidental with the construction of the Interstate highway system in the Northeast.

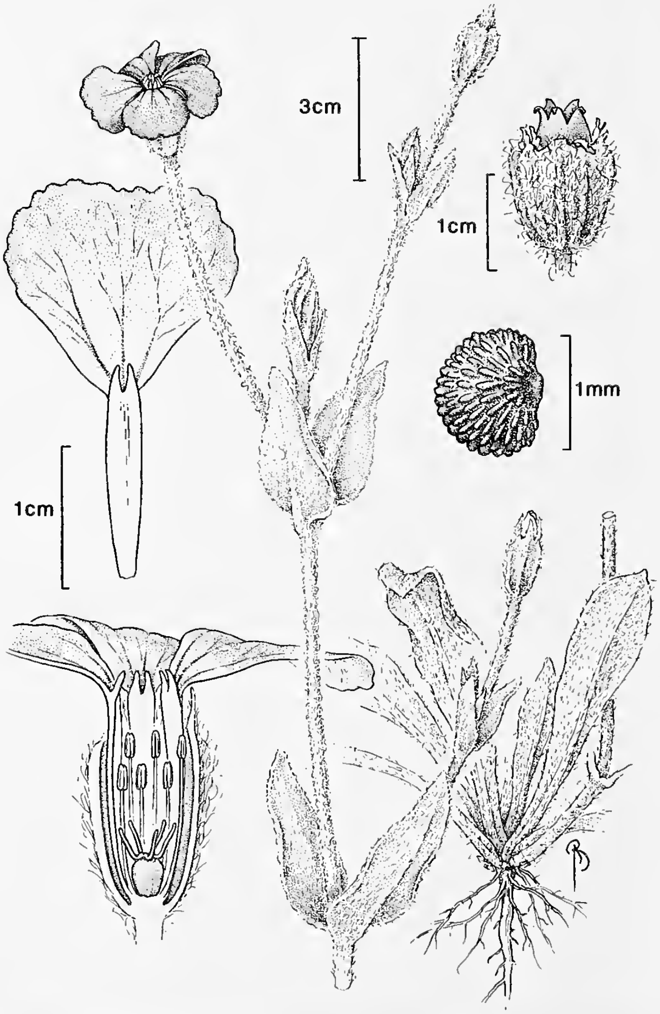




2. *Lychnis chalcedonica* L.
Common Names: Maltese Cross, Scarlet Lychnis, London Pride, Fireballs, None-such, Jerusalem Cross, Knight's Cross
Type Description: Linnaeus, Species Pl., p. 436, 1753
Origin: A native of Northern Eurasia
Habitats: Escaping to woodland borders, meadows, fields, roadsides, waste places and thickets
Habit: Erect or spreading, leafy perennial herbs
Flowering: June-September
Fruiting: July-November
General Distribution: Escaped from cultivation in North America from Newfoundland to Minnesota, south to Pennsylvania
Description: Plants with **bisexual** flowers; **stigmas** minutely papillose receptive areas 1-2 mm long on the dorsal tips of the styles; **styles** 5 (6), free, capillary, 3-6 mm long, green, somewhat spreading from the ovary tip, green, purplish toward the stigmatic zone; **ovary** obovoid-cylindric 4-5 mm long, ca. 3 mm broad, shiny green, glabrous, borne on a gynophore; **fruit** a shiny, ovoid, tan capsule, enclosed in the persistent calyx tube, dehiscing by 5 (6) acute-tipped valves for less than a third its length, 7-9 mm long, 5-7 mm broad, borne on a carpophore 6-11 mm long, and included in the clavate, persistent calyx tube; **seeds** copious, ca. 0.8 mm broad, brown, tuberculate; **stamens** 10, attached just below the ovary at the apex of the androgynophore; **anthers** ca. 1 mm long, golden-brown or orangish; **filaments** slender 4-13 mm long, curved outward toward tips, greenish hyaline below, orange toward tips; **perianth** of two whorls, with a fringe of ligule-like appendages at the base of the petal limbs; **petals** free, distinctly divided into claw and limb, the claw 13-19 (21) mm long, strap-like, barely exceeding the calyx tube, very narrow an greenish below, expanded and 3-4 mm broad above, where it is somewhat membranous and hyaline with a small keel on the abaxial side and a few hirsute hairs at the margin, the limb diverging at a right angle from the claw tip, 5-13 (16) mm long, 4-12 mm broad, oblanceolate to obspatulate, tip bifid, the notch 2-6 mm deep with a rounded sinus, lobes entire or slightly erose, scarlet to bright orange-red (rarely white), 2 ligulate coronal scales borne at the limb base (claw apex), ovate to lanceolate-tubular, 1.8-3.6 mm long, ca. 1 mm broad, acute or notched at tips, colored like the petal

limbs; **sepals** 5, lobe tips acuminate, narrowly hyaline-margined, 2-6 mm long, calyx tube cylindric, 12-17 (20) mm long, green, 10-ribbed, hirsute to sparsely woolly with septate hairs, persistent, becoming clavate and somewhat inflated (up to 8 mm in diameter) around the stalked fruit; **pedicels** stout, hispid, 2-3 (4) mm long; **peduncles** like the pedicels, usually less than 1 cm long; **inflorescence** a dense, terminal cyme, flat-topped to hemispheric, often 4-10 cm broad; **bracts** of the inflorescence linear-lanceolate, 3-20 mm long, 1-4 mm broad, slightly hispid, particularly at the margins; **leaves** opposite, somewhat leathery, elliptic, ovate to ovate-lanceolate or oblanceolate, 2-8 (14) cm long, 1-4 (6) cm broad, with acute to obtuse tips, the bases attenuate to rounded, the lower ones often cordate and somewhat clasping, partially to wholly connate at the nodes, upper cauline leaves ciliate on margins and major veins, but the surfaces almost glabrous, lower leaves hirsute to sparsely villous throughout; **petioles** absent; **stipules** absent; **stems** erect or strongly ascending, 2-14 mm thick, tough, up to a meter tall or more, sparsely hirsute to moderately villous, not much branched, but with short, suppressed shoots bearing dwarf leaves (shoots) at the slightly enlarged **nodes**; **rhizomes** tough, woody; **root system** largely adventitious, fibrous (2n = 18, 24, 48).
Infraspecific Variation: White-flowered variants occur, but these are less commonly cultivated than those with orange, rose or salmon hues. There is also a large-flowered, 'Grandiflora' cultivar.
Importance: This is a showy garden perennial, grown widely around the world in north-temperate climates, escaping occasionally, but not usually extremely aggressive as a weed.





3. ***Lychnis coronaria*** **(L.) Desr.**
Common Names: Rose-campion, Mullein Pink, Gardener's-delight
Type Description: Linnaeus, Species Pl, I., p. 436, 1753
Synonyms: *Agrostemma coronaria* L., *Coronaria coriacea* (Moench) Schischk. & Gorschk.
Origin: A native of southeastern Europe
Habitats: Roadsides, fields, clearings, shores, borders and woodlands as a naturalizing escape from cultivation
Habit: Erect, rhizomatous perennial herbs
Flowering: June-August
Fruiting: June-September
General Distribution: New Brunswick to British Columbia, south to Oregon and Louisiana, escaping cultivation and naturalized in widely scattered places between
Description: Plants with **bisexual** flowers; **stigmas** (4) 5, linear; **styles** (4) 5, filamentous, 2-3 (5) mm long; **ovary** ovoid, subsessile; **fruit** an elliptic to obovoid-cylindric capsule, smooth, tan, 9-14 (17) mm long, 6-10 (13) mm broad, sessile or carpophore less than 2 mm long, opening by 5 acute valves 2-4 mm long that are often shallowly bifid; **seeds** many, 0.5-0.8 mm long and broad, plump, gray-brown to black, bluntly tuberculate;

stamens 10; **anthers** narrow, ca. 2 mm long, dorsifixed; **filaments** slender, 10-14 mm long; **perianth** of 2 whorls, lacking an epicalyx; **petals** 5, divided into claw and limb, the claw paler than the limb 10-15 (20) mm long, 2-3 mm broad, the limb broadly oval to obovate, up to 17 mm long and broad, pale red to dark red-purple (rarely white), margin entire or shallowly emarginate, coronal scales borne in pairs, slightly included within the corolla at the limb-claw junction, lance-acuminate or shallowly bifid, 2-3 mm long; **sepals** 5, the free lobes attenuate, 3-5 mm long, often tortuous to spirally contorted, densely to sparsely woolly-tomentose, the calyx tube (8) 10-14 (20) mm long, obovate, becoming inflated and up to 14 mm broad in fruit, 10-ribbed, the ribs somewhat raised and darker green, the calyx tube surface covered with a dense, gray to silvery, woolly tomentum; **pedicels** stout, up to 3 mm in diameter, 1-12 cm long, elongating as the flower develops; **inflorescence** of several axillary and terminal, obscurely cymose clusters, the flowers (often 3 per cluster) developing, one at a time, the pedicel greatly-elongating during development (or rarely flower solitary); **bracts** leaf-like, 4-20 mm long, up to 5 mm broad, broadly lanceolate with acute to acuminate tips and entire margins, woolly-tomentose, directly subtending the short pedicels before elongation, but remote by the time of flowering; **leaves** dimorphic, **cauline leaves** paired, mostly 2-8 (11) cm long, 1-3 (4) cm broad, broadly lanceolate to elliptic or obovate with entire margins, densely woolly-tomentose, gray to silvery surfaces, margins, a strong midrib, apiculate to acute or obtuse (rounded) woolly-tufted tips, and bases tapering or slightly auriculate at the point where clasp the stem, **basal leaves** like the cauline ones, except densely clustered in rosettes, up to 25 cm long and 5 cm broad, narrowly to broadly obovate to spatulate, and often tapered at base into poorly defined **petioles**; **stipules** absent; **stems** terete, woolly-tomentose, up to 7 cm in diameter and 85 cm tall, erect or ascending from a woody **rhizome**; **root system** adventitious ($2n = 24$).
Infraspecific Variation: Flower color is quite variable in cultivars, ranging from rose to salmon, brick-red, purple or white.
Importance: This is a showy garden perennial or biennial, grown almost worldwide, that escapes and becomes naturalized widely in Eurasia and northern North America.

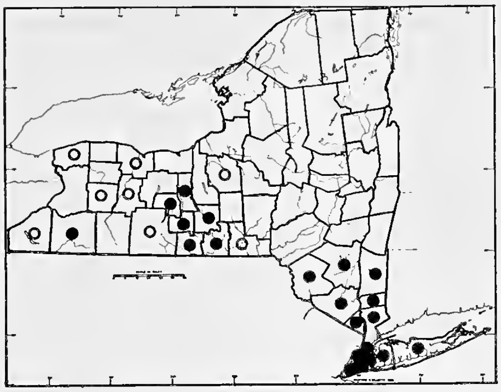
Note: *Lychnis viscaria* L., German catchfly, has been reported as a rare escape in New York State. The plants have spike-like panicles of rosy flower clusters, zones of viscous hairs at the internodes, and the basal rosettes of oblanceolate leaves.

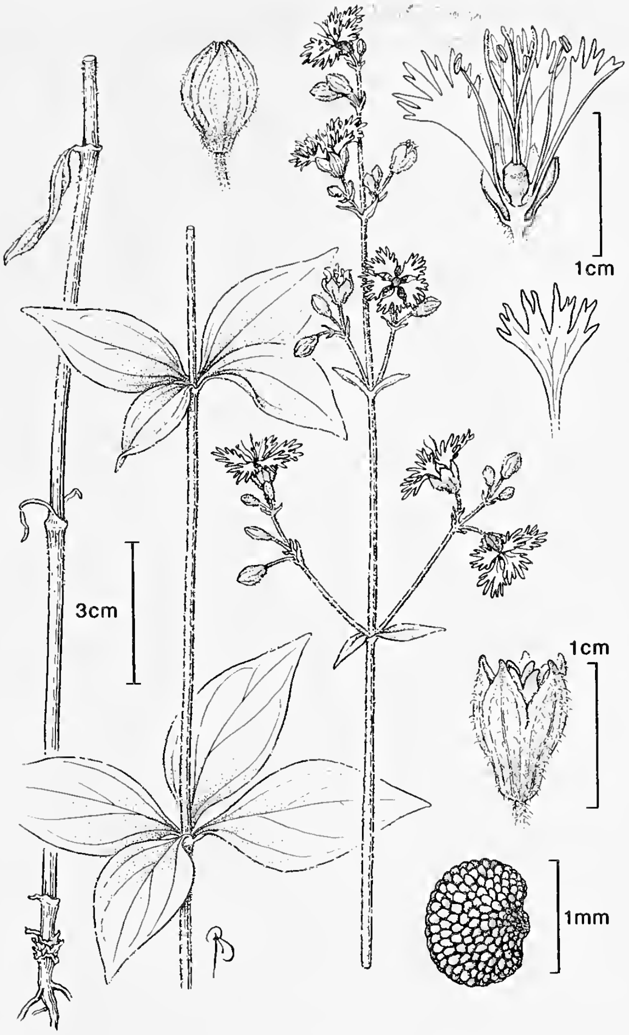
21. SILENE

Common Names: Campion, Catchfly, Pink
Authority: Linnaeus, Species Pl. I, p. 416, 1753
A genus of 500-700 species, native primarily in north-temperate, boreal and montane habitats around the world. The group is best represented in Eurasia. A reinterpretation of generic characters has led to the transfer of certain species from the closely related genus *Lychnis* into *Silene*. The showier species, called pinks, catchflies and campions, are popular in horticulture, grown widely in borders, annual and perennial beds, especially in rock gardens.
Description: Plants with **bisexual** flowers or dioecious; **stigmas** 3 (4 or 5); **styles** 3 (4 or 5); **ovary** 1, usually stalked, unilocular 3- to 5-chambered, or partially so toward the base; **ovules** numerous; **fruit** a capsule, opening by 6 (8 or 10) teeth, borne on a **carpophore** or subsessile; **seeds** many, small, often muricate or tuberculate; **embryo** strongly curved around the **perisperm**; **stamens** 10; **filaments** slender; **anthers** dorsifixed; **perianth** of 2 distinct whorls, lacking a distinct epicalyx; **petals** 5, free, usually strongly divided into a narrow, basal claw (sometimes auricled) and flared limb that is often bifid or otherwise cut; **coronal scales** present at the junction of the petal claw and limb (or absent); **sepals** 5, with short, free lobes, united for most of their length into a calyx tube, 10-35+ veined, persistent and becoming more or less inflated in fruit; **pedicels** slender to stout; **inflorescences** various, often cymose or paniculate, or flowers solitary; **bracts** paired or whorled, sometimes leaf-like; **leaves** paired, entire, connate-clasping at base; **petioles** usually absent or poorly defined; **stipules** absent; **stems** erect or ascending or cespitose, from perennial **rhizomes**, annual or biennial **taproots**.

KEY TO SPECIES

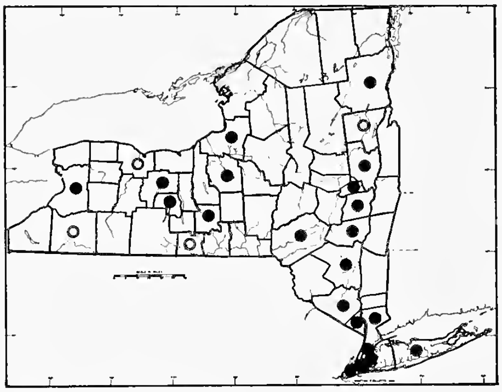
1. Cauline leaves mostly in whorls of 4, subequal in size; petal margins conspicuously lacerate-fringed . . . . 1. *S. stellata*
1. Cauline leaves paired (sometimes with clusters of smaller leaves in their axils); petals margins not fringed, often bifid to entire . . . . (2)
 2. Surface of the calyx tube glabrous . . . . (3)
 2. Surface of the calyx tube pubescent . . . . (6)
3. Petals white (rarely pink-tinged); internodes lacking viscous zones; calyx veins inconspicuous, branching, up to 20 in number at the base of the tube . . . . (5)
3. Petals pink, red, purple or lacking (rarely white); internodes often with golden to dark viscous zones; veins of the calyx tube 10 or fewer, unbranched, often prominent or ridged . . . . (4)
 4. Ovary distinctly stalked; fruiting calyx tube conforming to the stalked capsule within, to become cylindric-turbinate; petals showy . . . . 2. *S. armeria*
 4. Ovary subsessile; fruiting calyx tube conforming closely to the sessile, elliptic-obovoid capsule; petals usually inconspicuous and thread-like (or lacking) . . . . 3. *S. antirrhina*
5. Stipe of the capsule (within the calyx tube) minutely pubescent, ca. 1.5 mm long; calyx closely conforming to the mature fruit, its veins not conspicuously netted; capsule teeth narrow, acuminate, exserted from the calyx on dehiscence . . . . 4. *S. cserii*
5. Stipe of the capsule glabrous, usually 2-3 mm long; the calyx conspicuously inflated in fruit, its veins strongly reticulate; capsule teeth acute, not usually exserted from the calyx after dehiscence . . . . . 5. *S. vulgaris*
 6. Plants cespitose, with dense tufts of oblanceolate to broadly spatulate basal leaves; flowering stems with 1-3 pairs of cauline leaves, usually less than 20 cm tall, with clustered, showy, terminal cymes. . . . . 6. *S. caroliniana*
 6. Plants not cespitose; flowering stems elongate, usually with many pairs of cauline leaves; inflorescences ranging from spikes to open cymes and panicles . . . . (7)
7. Flowers sessile or subsessile, borne in pairs of spike-like cymes at the branch tips (sometimes in upper leaf axils as well); fruiting calyces remaining subsessile, appressed upward against the axis . 7. *S. dichotoma*
7. Flowers mostly with well-developed pedicels, in open cymes or panicles; fruiting calyces not appressed upward on the axis of the infructescence . . . . (8)
 8. Capsule teeth 6; styles 3; flowers bisexual, their subtending floral bracts narrowly lanceolate; seeds gray-brown with blunt, dark-tipped tubercles . . . . 8. *S. noctiflora*
 8. Capsule teeth 10; styles 5; flowers unisexual, the subtending bracts deltoid to broadly lanceolate; seeds brown with evenly colored, blunt to acute tubercles . . . . (9)
9. Flowers white; capsule ovoid, the aperture somewhat constricted on dehiscence, the marginal teeth erect or slightly spreading . . . . 9. *S. latifolia*
9. Flowers rose or pink (rarely white); capsule globose, often gaping on dehiscence, the teeth strongly reflexed . . . . 10. *S. dioica*

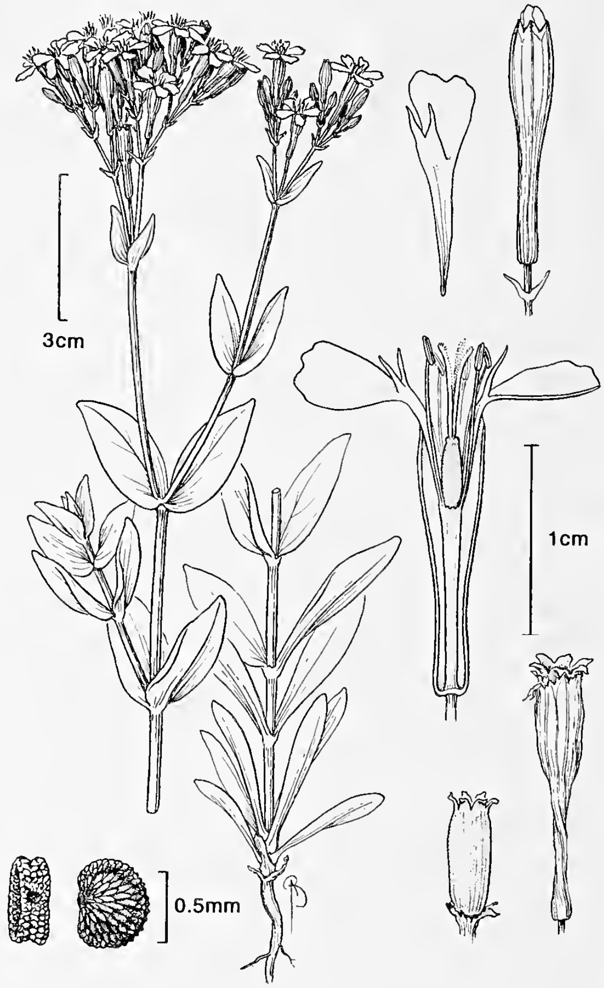




1. *Silene stellata* (L.) Ait. f.
Common Names: Starry Campion, Widow's-frill, Thermon Snakeroot, Four-leaved Campion
Type Description: Linnaeus, Species Pl. I., p. 414, 1753
Synonyms: *Cucubalus stellatus* L., *Evactoma stellata* (L.) Nieuwl., *E. stellata* var. *scabrella* Nieuwl., *S. stellata* var. *scabrella* (Nieuwl.) Palmer & Steyerm., *S. scabrella* (Nieuwl.) G. N. Jones
Origin: Native to eastern North America
Habitats: Dry, rocky places including woodlands, thickets, clearings, banks and forest margins
Habit: Erect to ascending, somewhat woody, perennial herbs
Flowering: July-October
Fruiting: July-December
General Distribution: Massachusetts to North Dakota, south to Texas and Georgia
Description: Plants with **bisexual** flowers; **stigmas** 3, papillose areas near the style tips; **styles** 3, slender, 11-17 mm long, exserted from the corolla, free to the base, where they are attached on a pale, hemispherical swelling or cap formed by the valves; **ovary** 1, borne on a short stipe (androgynophore); **fruit** a highly glossy capsule, olive green to tan, elliptic 5-8 mm long, 4-6 mm broad, dehiscing by 6 sharp, triangular valves that reflex strongly, further splitting the capsule to about 2/3 its length; **carpophore** minutely woolly, 1-2 mm long; **seeds** many, dark golden to reddish-brown, reniform, somewhat compressed, 1.2-1.6 mm long, ca. 1 mm broad, surfaces rugose, with rounded papillae; **stamens** 10; **anthers** pale, elongate, ca. 1 mm long, dorsifixed; **filaments** slender, 7-13 mm long, attached at the expanded upper rim of the stipe; **perianth** of 2 whorls; **petals** 5, pale pink or white, 13-22 mm long, claw ca. 1 mm broad, limb 3-6 mm broad, the margin fringed with lacerations up to 5 mm deep, coronal scales lacking; **sepals** 5, calyx lobes 3-5 mm long, 3-6 mm broad, acuminate to apiculate, with some hyaline tissue at the margins, the calyx tube cylindric-turbinate in flower, becoming inflated and campanulate in fruit, 7-12 mm long, up to 13 mm broad in fruit, the surface pale green, sparsely to densely puberulent; **pedicels** 3-9 mm long, hispidulous to short-woolly; **inflorescence** an elongate, compound dichasium, with spreading lower branches; **bracts** of the inflorescence paired, 2-8 mm long, ciliate-margined greenish with somewhat hyaline margins; **leaves** mostly borne in whorls of 4 (rarely 6) or paired near the inflorescence or stem base, (3) 4-11 cm long, (0.5) 1-5 (6) cm wide, broadly ovate to narrowly lanceolate, with long-acuminate tips and rounded to attenuate bases, clasping at the swollen nodes, leaf margins entire, often scabrescent, upper leaf surfaces often scabrescent, the lower scabrescent to puberulent; **petioles** absent; **stipules** absent; **stems** up to 1 m tall, erect-ascending, tough, woody, the **nodes** swollen into conspicuous woody collars, stem surfaces green or reddish on lower internodes, puberulent to short hispid; **rhizome** tough, woody; **root system** adventitious, fibrous (2n = 48).

Importance: Frequent in gardens as an interesting horticultural novelty, due to its woody canes with star-like leaf whorls and fringed flowers. These plants are grown in sunny gardens and along borders where erect, perennial plants up to a meter tall are preferred.





2. *Silene armeria* L.

Common Names: Sweet-William, Garden Pink, Catchfly, or Campion, None-so-pretty

Type Description: Linnaeus, Species Pl. Ed. 2, p. 601, 1762

Synonym: *S. glauca* Salisb. *S. lituanica* Zapal.

Origin: A native of Eurasia

Habitats: A garden escape, apparently requiring soil disturbance to become naturalized: roadsides, construction sites, vacant lots and dumps

Habit: Erect-ascending annual or biennial herbs

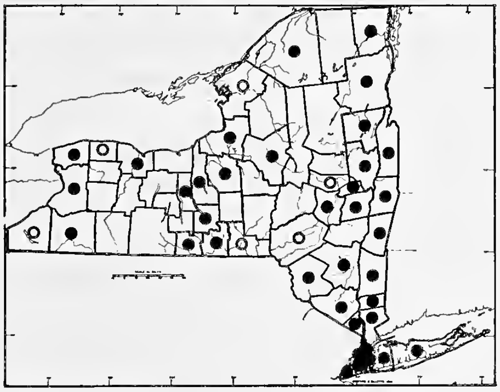
Flowering: June-October

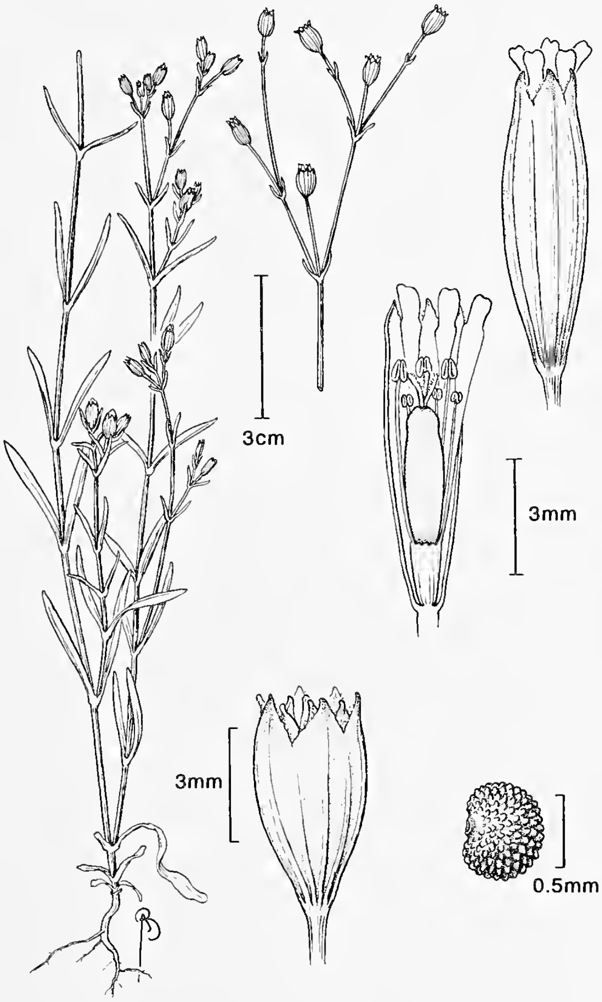
Fruiting: Late June-November

General Distribution: Widely escaped from cultivation from Quebec to British Columbia, southward to California and Arkansas (South America); also escaped in Africa and in Eurasia, where it was originally native

Description: Plants with **bisexual** flowers; **stigmas** 3 (4) linear, puberulent; **styles** 3 (4), filamentous, hyaline, 4.8-5.2 mm long; **ovary** 1, green, cylindric, 3-4 mm long, ca. 1 mm broad, borne on a **stipe** consisting of a gynophore ca. 1 mm long, terminal to a columnar androgynophore, 6-14 mm long in flower, 0.6-1.1 mm broad; **fruit** an almost completely 3-chambered capsule, smooth, tan, cylindric, 5-9 (10) mm long, 2.1-3.2 mm broad, enclosed within the persistent calyx, dehiscing by 6 (rarely 8) recurving teeth, ca. 1.3 mm long; **carpophore** 7-16 mm long, ca. 1 mm broad, glabrous; **seeds** many, dark brown, reniform and laterally compressed with sharp edges, 0.6-0.7 mm long, irregularly rugulose; **stamens** usually 10, diverging ca. 1 mm below the ovary base, with the claw and petal bases; **anthers** oblong, flat, 0.5-1.1 mm long, pale yellow or colored like the petals; **filaments** white, thread-like, 0.8-1.3 mm long their lower extremities sheathing, adnate to the androgynophore for most of its length; **perianth** of 2 whorls; **petals** 5, the claws greenish, linear-oblanceolate, up to 1.6 mm broad at the junction with the limb, where they bear a pair of ligulate appendages (coronal scales) 2-3 mm long, ca. 1 mm broad, colored like the petal limbs, but free and erect, petal limbs diverging at right angles to the claws (as in salverform corollas) pink to deep rose, lavender (or white), 4.5-6.5 mm long, 4.1-5.6 mm broad, bilobed, emarginate, or slightly ragged at tip, somewhat pleated toward the base; **sepals** 5, the lobes ca. 1 mm long, brownish, even in flower, acute to obtuse or mucronate, calyx tube 12-15 (17) mm long, cylindrical, expanded gradually toward the tip, pale green to pinkish, conspicuously 10-ribbed and fluted, persistent in fruit, becoming clavate with the development of the capsule and shrinkage in the area of the stipe; **pedicels** glabrous, 2-5 mm long, or absent; **peduncles** stiff, glabrous, 8-16 (22) mm long; **inflorescences** congested, terminal and axillary flat-topped cymes and panicles

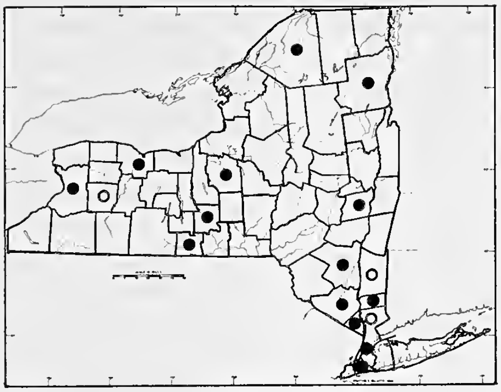
of few to many flowers; inflorescence **bracts** lanceolate with mucronate tips, greenish to almost white, those directly subtending calyx tubes ca. 2 mm long, up to 6 mm or longer below; **cauline leaves** mostly 1-6 cm long, 0.5- 2.5 (3) cm broad, ovate to narrowly oblanceolate, glabrous, margins entire, tips acute to rounded. bases attenuate to rounded or slightly cordate, clasping; **basal leaves** like the cauline leaves, but obovate to spatulate and soon withering; **petioles** absent; **stipules** absent; **stems** strongly ribbed and channeled, pale greenish-tan, glabrous to sparsely puberulent, 15-40 (55) cm tall unbranched or with ascending flowering branches; **root system** a short, abruptly tapered annual or biennial taproot with strong laterals and fibrous rootlets (2n = 24).
Infraspecific Variation: Stems may be simple or much-branched above, varying from glabrous and glaucous to puberulent and dark green. Diffusely branched plants with non-congested inflorescences are known in the wild in the eastern Mediterranean Region, and such plants have been found as escapes in upstate New York, sometimes designated *S. armeria* var. *sparsiflora* Schur. Flower color is variable from pink to purple or white, and plants with almost entire petals have been called var. *lituanica* Zapal. Such variants probably do not deserve taxonomic recognition.
Importance: This is a very popular, showy plant in cultivation, where it behaves as an annual. Seeds are often collected in fall and sown in tilled soil in the spring to promote germination.

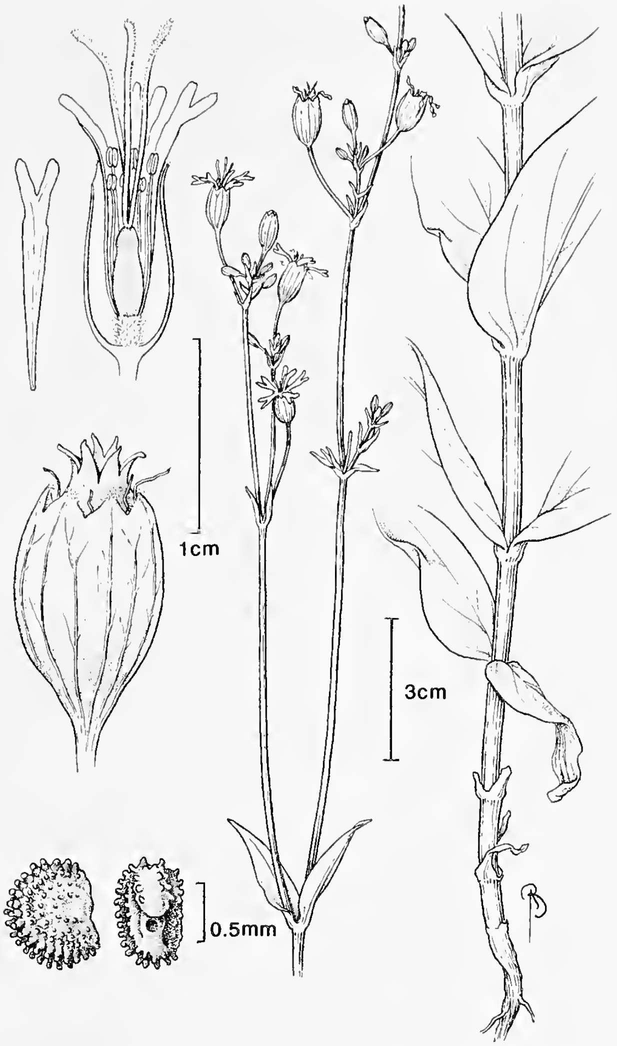




3. *Silene antirrhina* L.
Common Names: Sleepy Catchfly
Type Description: Linnaeus, Species Pl. I, p. 419, 1753
Synonyms: *S. antirrhina*: var. *depauperata* Rydb.; var. *divaricata* Robins.; forma *apetala* Farw.; f. *bicolor* Farw.; f. *deaneana* Fern., *S. divaricata* (Robins.) Smyth
Origin: Native to the Americas
Habitats: Clearings, meadows, fields, open wood lands, roadsides and waste places (a somewhat weedy native plant)
Habit: Slender, erect-ascending (rarely decumbent), annual and biennial herbs
Flowering: May-September (in NY)
Fruiting: June-October
General Distribution: New Brunswick and Quebec to British Columbia, south to Mexico and South America (naturalized elsewhere)
Description: Plants with **bisexual** flowers; **stigmas** 3, pale, ca. 1.3 mm long, ciliate; **styles** 3, ca. 1.5 mm long, free; **ovary** 1, ovoid, ca. 3 mm long, 2 mm broad, borne on a short androgynophore, the 6 valves forming a pale valvate cap, the apex of the olive-green ovary nearly completely 3-chambered; **fruit** an elliptic to ovoid capsule, (3) 6-8 (10) mm long, (2) 3-4 (5.5) mm broad, smooth, olive to tan, opening by 6 short, triangular valves and closely invested within the persistent calyx, from which it is often slightly exserted upon dehiscence; **carpophore**

ca. 1.5 mm long; **seeds** many, 0.6-0.7 mm long, plump, reniform, the surfaces charcoal gray (somewhat glaucous) to dark, glossy brown, covered with sharp tubercules; **stamens** 10; **anthers** oblong, dorsifixed, golden or pale; **filaments** very slender, 6-9 mm long; **perianth** of 2 whorls, or petals lacking; **petals** (0-) 5, free, not showy, 2-12 (16) mm long, often less than 1 mm broad, linear and poorly differentiated into claw and limb or spatulate, the limb, when expanded, usually less than 2 mm broad, bifid or entire, (or limbs sometimes linear, arched or twisted), coronal scales lacking or obscure, petals pink to roseate with pink, rosy, dark red, purplish or white tips; **sepals** 5, the calyx lobes 0.9-1.7 mm long and broad, obtuse to acute, usually reddish-purple, at least along the ciliate margins, calyx tube cylindric in early flower, becoming fusiform, urceolate, persistent and closely conforming to the elliptic to ovoid capsule in fruit, 4.0-9.7 mm long, 2.3-4.5 (5.6) mm broad, with 10 prominent veins that extend to the pedicel, surface smooth, shiny green, glabrous; **pedicels** very slender, ribbed, at least above, 3-30 (36) mm long, glabrous; **inflorescence** a many-flowered panicle, a series of axillary and terminal clusters (or single flowers); **bracts** of the inflorescence paired, linear to lanceolate, 1-6 (9) mm long, pale green often with purplish tips and entire, ciliate margins (rarely bifid); **cauline leaves** paired, linear to broadly lance-elliptic or oblanceolate, mostly 1-5 (7) cm long, 0.2-1.5 (2) cm broad, usually puberulent, at least along the veins and the entire margins, tips acute to acuminate, bases connate or incompletely so, clasping the node with villous hairs along the margin of their juncture; **basal leaves** similar, or up to 9 cm and obovate to spatulate; **petioles** absent; **stipules** absent; **stems** erect, ascending or lax, up to 80 cm long or tall, solitary or more often branched above, ribbed and channeled, irregularly short-puberulent and usually with golden to dark glutinous zones, up to several cm long on the internodes, their sticky excretions associated with a few longer hairs and soft glandular tissues; **root system** an annual or biennial taproot (2n = 24).
Infraspecific Variation: Petals are sometimes abortive or totally lacking. Petal tips may be entire or emarginate, and the several flower colors include bicolored variants. These traits have been used to distinguish varieties and forms that seem to lack geographic or taxonomic significance.
Importance: Although this species is considered native over a broad geographic range in the Americas, it is an aggressive weed, often associated with disturbance. Its distribution range may have expanded significantly with the advent of the migration of mankind into the New World.





4. *Silene cserii* Baumg.

Common Names: Campion

Type Description: Baumgarten, Enum. Stirp. Transs. vol. 3, p. 345, 1816

Synonyms: *S. cserei, S. czerei* and *S. czerii* of authors, *S. fabaria sensu* Rydb., not (L.) Sibth. & Sm.

Origin: Native to southeastern Europe

Habitats: Disturbed ground, roadsides, quarries, particularly widespread along railways

Habit: Erect or ascending biennial herbs

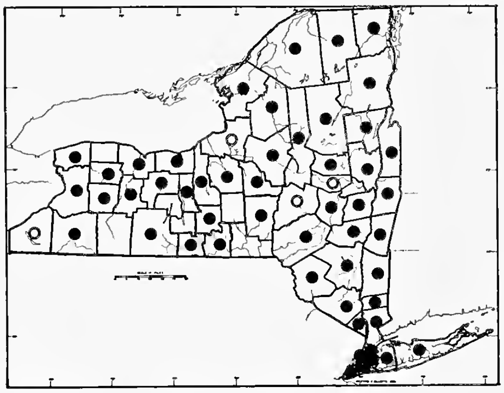
Flowering: Late May-September

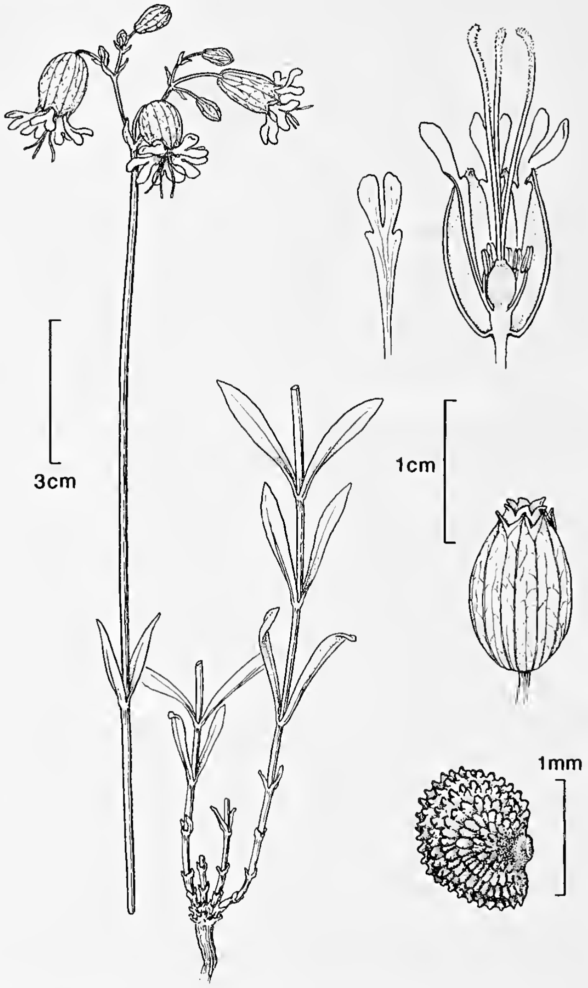
Fruiting: June-November

General Distribution: Quebec to British Columbia, Montana, Indiana, Missouri, Ohio and southern Pennsylvania

Description: Plants with **bisexual** flowers; **stigmas** (1-) 3-5 (-8), the ciliate receptive line prominent expanded at the reddish-purple, somewhat flattened stigmatic tips of the styles; **styles** (2) 3-5 (-8), linear 10-15 (17) mm long, sometimes branched at tips; **ovary** 1, fusiforme, borne on a minutely pubescent gynophore, ca. 1 mm long; **fruit** an ovoid capsule, 8-13 mm long, 5-8 mm broad, tan, smooth and glossy, dehiscing by 6 narrowly acuminate valves 1-2 mm long that are only slightly reflexed and exserted from the flower after dehiscence; **carpophore** 0.9-1.6 mm long, minutely woolly-puberulent; **seeds** many, 0.8-1.0 mm long, triangular in outline to comma-shaped with concave sides, golden brown to chocolate, the surfaces strongly papillate, sometimes with stalked papillae; **stamens** 10; **anthers** linear-ovate, ca. 1.5 mm long, dorsifixed, golden; **filaments** linear, pale, up to 2 cm long; **perianth** of 2 whorls; **petals** 10-15 (18) mm long, white to creamy, claw mostly less than 1 mm broad, flared at the tip into a narrow, bilobed limb 4-5 mm long lobes 1-2 (3) mm long, obtuse at the tips, coronal scales obscure or lacking; **sepals** 5, calyx lobes deltoid, 1-2 mm long and broad, often ciliate-tufted at apex, calyx tube cylindric, becoming fusiform, 7-11 mm long, up to 8.2 mm broad inflating only to the dimensions of the mature fruit and closely investing it, tube surface green becoming pale, yellowish, glabrous, main veins ca. 20, 10 long and 10 short, sometimes dichotomously branching, but not strongly reticulate-anastomosing; **pedicels** glabrous, terete to ribbed, 5-25 mm long; **inflorescence** a narrow, raceme-like panicle (often a dichotomously branched pair), 7-30 (40) cm long, bearing up to 50 flowers; **bracts** of the inflorescence lanceolate, up to 6 mm long, often ciliate-margined; **leaves** 3-8 (10) cm long, 0.6-3.0 (3.8) cm broad, narrowly oblong to broadly ovate, acute to cuspidate, with connate-perfoliate bases (except basal leaves, which are more attenuate), margins entire, surfaces glabrous, somewhat glaucous; **stipules** absent; **stems** robust, erect, often grooved, green to yellow-green, glabrous, not conspicuously swollen at the nodes, up to 60 (75) cm tall; **root system** a thick, tough biennial taproot, pale in color, often contorted, with thick, lateral branches (2n = 24).

Infraspecific Variation: A biennial member of an extremely variable species complex of Eurasia. In Europe *S. cserii* is sometimes confused with *S. fabaria* (L.) Sibth. & Sm., which is said to differ from it in having succulent, smaller leaves, borne more basally, acute calyx lobes and only 10 main calyx veins. Plants approaching this condition occur in New York State, but inconsistency of characters prompts the recognition of a single species for the purposes of this flora.
Importance: A weed, primarily of railroad beds and waste places.



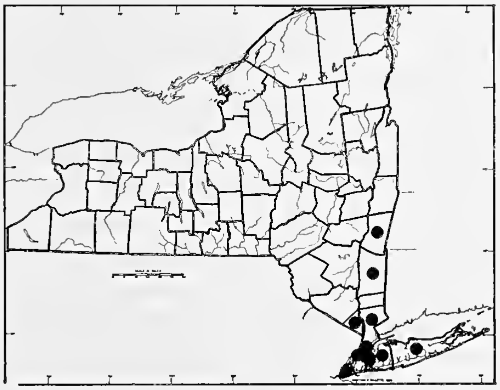


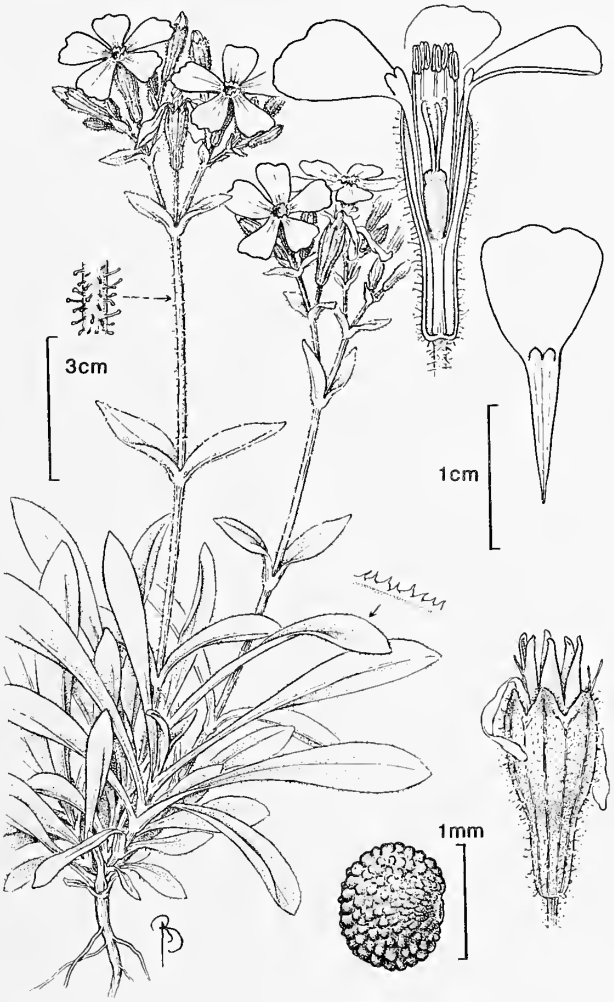
5. *Silene vulgaris* (Moench) Garcke
Common Names: Bladder Campion, Maiden's-tears
Type Description: Moench, Fl. Nord Mittle-Deutch., ed. 9, p. 64, 1869
Synonyms: *Behen vulgaris* Moench, *Cucubalus behen* L., *C. inflatus* Salisb., *C. latifolius* Mill., *S. cucubalus* Wibel, *S. inflata* (Salisb.) Sm., *S. latifolia* (Mill.) Britten & Rendle, not Poir., *S. venosa* (Gilib.) Aschers, a *nomen illeg.*
Origin: A native of Europe and eastern Asia
Habitats: A wide range of disturbed habitats, including roadsides, pastures and gardens, but also in less disturbed meadows, thickets and open forests
Habit: Sprawling-decumbent to erect perennial herbs
Flowering: April-November
Fruiting: June-December
General Distribution: Naturalized from Nova Scotia to British Columbia, scattered southward to southern California, Colorado, Arkansas and Georgia
Description: Plants with **bisexual** flowers; **stigmas** 3, papillose, filiform; **styles** 3, filiform, 12-20 (28) mm long, the tips sometimes recurved, free to their point of attachment on a pale valvate cap; **ovary** 1, ovoid, green, ca. 3 mm long, 1.5 mm broad, borne on a glabrous androgynophore (1.4-) 1.9-3.5 mm long; **fruit** a shiny, olive to tan, ovoid to oblong capsule, partially to fully 3-chambered, 7-9 (11) mm long, 6-8 mm broad, the teeth deltoid, 1 mm or less, acute, not strongly reflexed or exserted on dehiscence; **carpophore** glabrous, somewhat fluted, (1.4-) 2.0-3.8 mm long; **seeds** many, irregularly triangular to comma-shaped with 1 or 2 concave sides, 0.9-1.4 (2) mm long, dark brown, the edges and surfaces variably rugose to prominently papillose; **stamens** 10; **anthers** ca. 2 mm long, 0.5 mm broad, golden, dorsifixed; **filaments** slender, 9-15 (18) mm long; **perianth** of 2 whorls; **petals** 5, white (or pink tinged), the claw 6-13 mm long, linear below, expanded into auricles near the mouth of the calyx tube, the limb 5-8 (10) mm long, 3-5 mm broad, usually deeply cleft into 2 obtuse lobes, coronal scales absent or much reduced; **sepals** 5, broadly deltoid, 2-3 mm long, 2-4 mm broad, acute to slightly apiculate, margins ciliate, at least toward the tips, calyx tube cylindric to ovate in flower, becoming inflated, campanulate to broadly urceolate, 10-16 (20) mm long, 6-12 (14) mm broad, somewhat membranaceous,

loosely enclosing the capsule in fruit, the surface glabrous, greenish to yellowish or tan, often with a purple blush (or chalky), veins becoming strongly reticulate and slightly raised; **pedicels** slender, 3-15 (25) mm long, terete or angled, glabrous or puberulent; **peduncle** like the pedicels, up to 4 cm long; **inflorescences** open dichasia at branch tips, usually several per plant with 3-20 (30) flowers each; **inflorescence bracts** paired, pale, membranaceous, at least on the margins, ovate to lanceolate, 2-3 mm long, entire and glabrous or ciliate; **leaves** opposite, (linear) lanceolate to broadly elliptic or ovate, entire, 1.5-7.5 (9) cm long, 0.3-2.0 (3.6) cm broad, surfaces glabrous, punctate, margins glabrous or hirsutulous, the tips acuminate to obtuse-apiculate, bases broadly rounded to tapered or attenuate into poorly defined **petioles; stipules** absent; **stems** decumbent to ascending, tough, only slightly swollen at the nodes, internodes often grooved, glabrous or sparsely puberulent, greenish turning tan or reddish, up to a meter tall, the base a tough, perennial **caudex, stolon** or **rhizome** bearing a fibrous **root system** that is largely adventitious (2n = 24, 48).

Infraspecific Variation: *Silene vulgaris* is a polymorphic species with a number of named varieties. Biosystematic studies of this species in the European flora revealed at least 15 "life forms" (Aeschimann, 1985). The plants differ in floral morphology, including stipe length, calyx size and presence or absence of well-developed coronal scales. They may also be stoloniferous, rhizomatous, decumbent or erect. Bract shape and texture also vary, and different varieties and races show extremes, ranging from small, petioled, mostly basal, linear-lanceolate leaves to large, clasping, mostly cauline, ovate ones. Two statistically distinct seed morphologies have also been reported for the species. It is likely that both diploids and tetraploids are found in New York State, since the morphological spectrum described for Europe is well represented by naturalized plants here.

Importance: A prolific weed of disturbed ground, and an occasional pest in gardens.





6. *Silene caroliniana* Walt.

Common Names: Wild Pink, Common Pink, Carolina Pink

Type Description: Walter, Fl. Carol., p. 142, 1788

Synonyms: *Melandrium pensylvanicum* (Michx.) Rohrb., *S. caroliniana* ssp. *pensylvanica* (Michx.) Clausen, *S. caroliniana*: ssp. *wherryi* (Small) Fern.; var. *pensylvanica* (Michx.) Fern.; var. *wherryi* (Small) Fern., *S. pensylvanica* Michx., *S. wherryi* Small

Origin: Native to eastern North America

Habitats: Dry, often sandy soils, fields banks or cliffs in full sun or partial shade of open woods

Habit: Cespitose, perennial herbs

Flowering: April-June

Fruiting: May-August

General Distribution: Southern New Hampshire, southeastern New York and southern Ontario to Missouri, south to Alabama and South

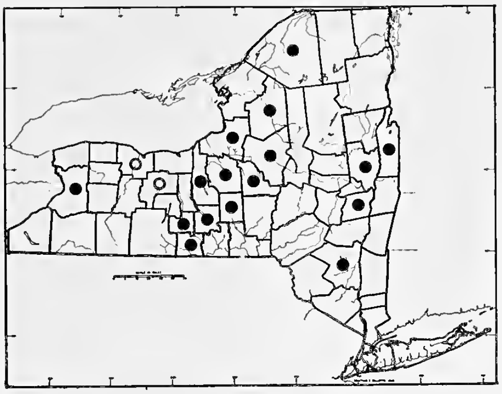
Carolina. Ours is so-called var. *pensylvanica*, which occurs mostly in the northern end of the range, then sporadically south to Tennessee and North Carolina

Rarity Status: This species is protected from exploitation by New York State law, but it is not listed by NYNHP in their rare plant status list. It is historically known from about 15 locations on Long Island and in the New York city boroughs, with 10 populations recorded northward to the southern Taconic range. Since a number of these populations are possibly extirpated, the species may be far rarer in the State than its current rank would suggest.

Description: Plants with **bisexual** flowers; **stigmas** 3, papillose zones ca. 1.5 mm along the style tips; **styles** 3, filiform, 6-10 mm long, free; **ovary** 1, the valvate cap ovate-hemispherical, 1.5-3.0 mm long, distinct from the ovary wall below, the ovary (below the cap) 3-6 mm long, hemispheric to broadly cylindric, borne on an androgynophore 5-9 mm long; **fruit** an ovoid to cylindric capsule, 9-13 mm long, 5-8 mm broad, dehiscing in the upper third by 6 golden-brown, leathery, lanceolate teeth, 3-4 mm long, the lower capsule thinner-walled, glossy, greenish to tan; **carpophore** stout, fluited, 5-8 mm long; **seeds** brown, 1.3-1.5 mm long, tuberculate, ovoid; **stamens** 10; **anthers** linear, 1.1-1.5 mm long, golden; **filaments** slender, free above the androgynophore, 9-16 mm long; **perianth** of 2 whorls; **petals** 5, pale pink to rosy or white, the distinct claw 7-14 (17) mm long, included to slightly exceeding the calyx, ciliate-margined, the limb showy, often diverging at a right angle, 5-14 (18) mm long, 3-12 mm broad, rounded to somewhat truncate at tip, entire or only slightly erose (less often emarginate or notched), coronal scales well-developed, colored like the petals, with 2 lobes, 2-3 mm long, ca. 1 mm broad; **sepals** 5, acute to bluntly deltoid, 1-3 mm long, 1-2 mm broad, greenish to purple, or with hyaline margins, glandular-hispid, the calyx tube (0.6) 1-2 (2.4) cm long, tapering upward from a slender base, turbinate or (in ours) cylindric, green below to rosy or deep purple above, short glandular-hispid, the 10 major veins somewhat raised; **pedicels** (glandular) hispid, 1-8 (14) mm long (or individual flowers may be sessile); **peduncles** like the pedicels, but up to 4 cm long; **inflorescence** of terminal clusters of relatively dense, showy, few-flowered cymes; **bracts** linear to ovate, leaf-like, glandular-pubescent to almost glabrous, less than 1 cm long; **leaves** paired on the flowering stems, but mostly in dense, cespitose, basal tufts; **cauline leaves** linear to broadly lanceolate, ovate or oblanceolate, one pair subtending the terminal inflorescence and usually 1-2 pairs (rarely 3) below, linear to lanceolate or oblanceolate 0.8-3.5 (5) cm long, 1-7 mm broad, perfoliate-clasping to indistinctly petioled, tips acute to obtuse, entire, ours glandular-hispid, especially along the entire margins; **basal leaves** numerous, tufted, (lanceolate) oblanceolate to spatulate, 1-11 cm long, 2-16 (20) mm broad at the widest point, both surfaces (in ours) glabrous, the tips acute to obtuse or apiculate, margins entire, ciliate, the bases long-attenuate into indistinct **petioles**; **stipules** absent; **flowering stems** glandular- hispid or merely short-hispid above, 2-20 (32) cm tall, spreading, ascending or erect, from cespitose, basal tufts, branching at or near ground level from an erect or ascending, woody **caudex** up to 1 cm in diameter (sometimes spirally twisted), and lateral **rhizome** system; **root system** fibrous (2n = 48).

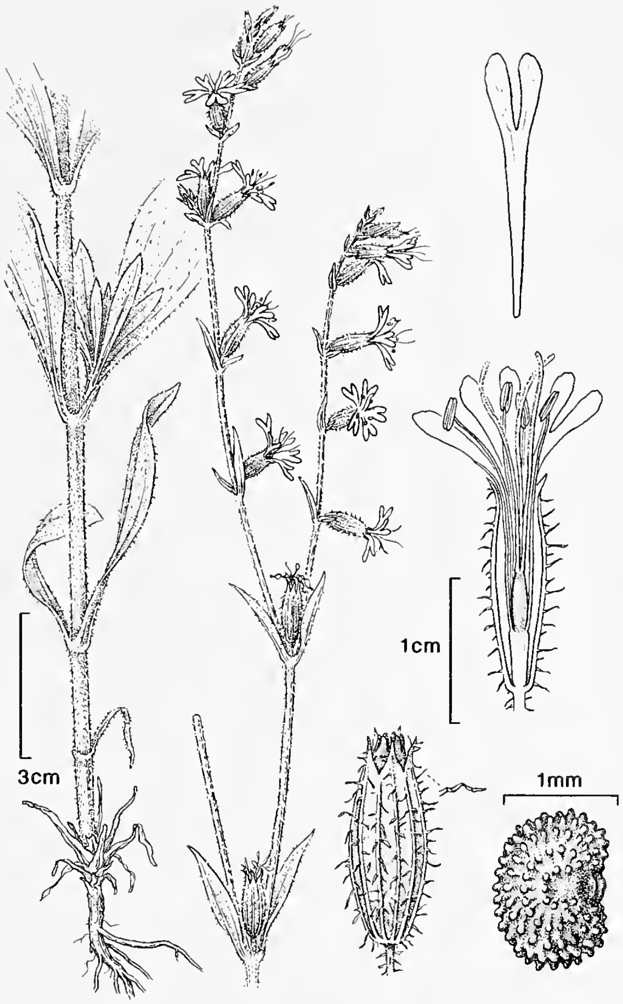
Infraspecific Variation and Hybridization: Three infraspecific taxa are often recognized, either at the varietal or subspecies level, but these are far from well-differentiated, and intergrade, especially in the southern part of the distribution range of the species. In plants of the north, often called *S. caroliniana* var. *pensylvanica*, the calyx tube is slender, narrowing further toward the base, the plants are copiously glandular-hispid (except for basal-leaf surfaces), petal claws slightly exceed the calyx tube, and flowering stems may reach heights up to 30 cm. In so-called var. *wherryi*, plants are shorter, mostly clothed with eglandular hairs on the upper stems and the calyx, which is broader, more evenly tubular and not exceeded by the petal claws. Other characters, (*e.g.*, cauline leaf shape) have also been cited in making infraspecific distinctions; however, plants studied in preparation for this publication showed a broad range of variability, and geographic correlations seemed far less obvious than indicated in the literature. *Silene caroliniana* is known to hybridize naturally with *S. virginica* L., the scarlet catchfly, in the southern Piedmont (Mitchell & Uttal, 1968). The hybrids are taller than typical plants of the wild pink, with narrower, darker pink, notched petals; thus, the cleft petals more common in southern populations may have been derived through introgression.

Importance: Wild pink is widely grown ornamentally in moderate climates, especially in open, sandy places and rock gardens. Its cespitose habit and dense clusters of showy, pale pink, salmon or white flowers make it a horticultural favorite.



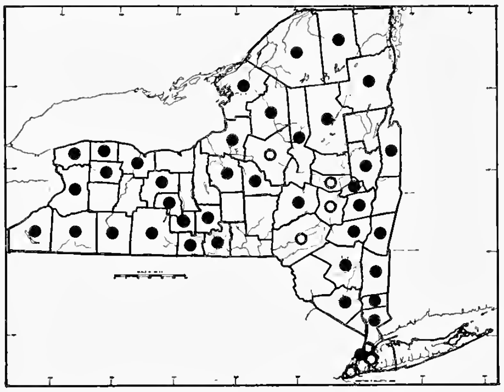
7. *Silene dichotoma* Ehrh.

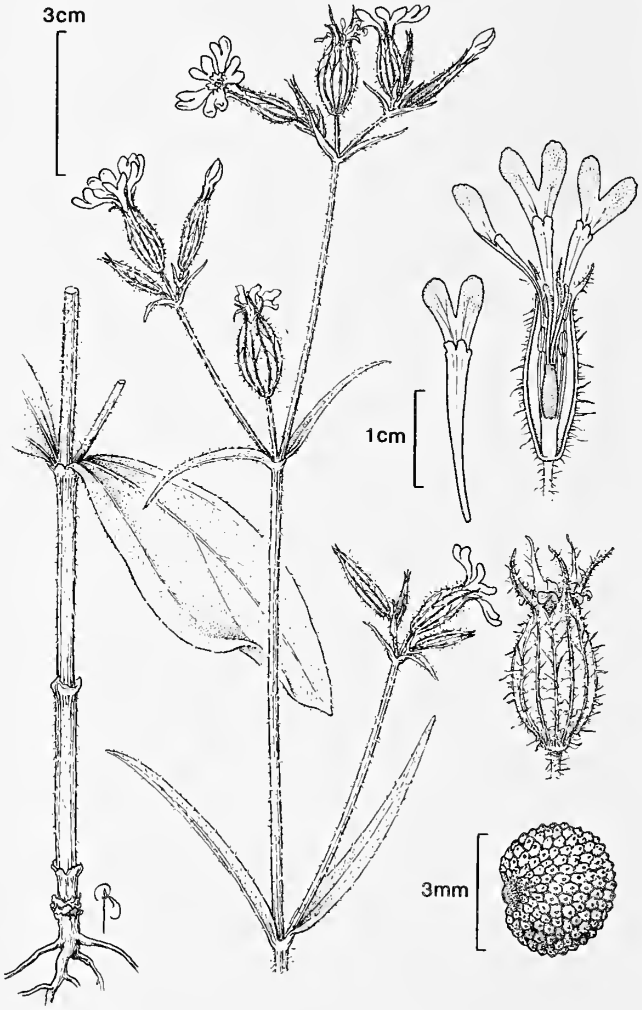
Common Names: Forked Catchfly, Forking Catchfly
Type Description: J. Ehrhart, Beitr. 7, p. 143, 1792
Synonyms: *S. anglica* and *S. gallica* of NY authors, not L., *S. racemosa* Otth in DC.
Origin: A native of Eurasia
Habitats: Roadsides, fields, lake shores and waste places
Habit: Robust, erect or ascending, annual herbs
Flowering: June-September
Fruiting: June-November
General Distribution: Of sporadic, weedy distribution from southern Quebec to British Columbia, south to California, the Carolinas and Georgia (Texas)



Description: Plants with **bisexual** flowers or **polygamomonoecious; stigmas** 3, papillose zones on the style branches; **styles** 3, filamentous, pale, 7-14 (16) mm long; **ovary** 1, fusiform-cylindric, ca. 5 mm long, 1 mm broad, borne on a smooth androgynophore ca. 2 mm long; **fruit** an ovoid capsule, 6-8 mm long, 4-6 mm broad, smooth, greenish-tan, dehiscing by 6 short, acute valves; **carpophore**, stout, 1.8-2.8 (3.7) mm long, glabrous, fluted; **seeds** 1.1-1.4 mm long, comma-shaped with indented sides, shallowly indented along the dorsal margin, dark brown, prominently rugose-papillose; **stamens** 10; **anthers** 1.5-2.5 mm long, golden, dorsifixed; **filaments** slender, (4-) 9-17 mm long; **perianth** of 2 whorls of 5; **petals** 5, white (rarely pinkish), the claw slender, tapering toward base from about 1 mm in width at summit, the limb 6-8 mm long, 3-4 mm broad, tips obtuse, shallowly to deeply bilobed (entire or minutely erose), coronal appendages ca. 1 mm long and broad, colored like the petals; **sepals** 5, acute, 1-2 mm long, with minutely woolly-fringed margins, calyx tube slenderly tubular-cylindric in flower, 0.9-1.7 mm long, 3-5 mm broad, becoming elliptic to fusiform, up to 6.3 mm broad, not inflated, closely conforming to the fruit, surfaces minutely villous between veins, coarsely hispid (with jointed trichomes) along the 10 prominent veins; **pedicels** short-hispid, up to 2 (3) mm long or often very short, the flowers subsessile; the **inflorescences** are spike-like monochasial cymes, borne in terminal pairs, sometimes in upper leaf axils as well, flowers oriented laterally or slightly drooping, but becoming appressed upward and ascending in fruit; **bracts** paired, with ciliate margins and veins, grading from green, linear, leaf-like structures in the lower inflorescence to obovate, scarious floral bracts above, upper bracts 3-6 mm long, 1-4 mm broad; **leaves** paired at the ± swollen, jointed nodes, linear-lanceolate to oblanceolate, elliptic or obovate, 1-6 (8) cm long, 3-35 (40) mm broad, margins entire, hispid to villous, lamina often prominently 3-veined, the surfaces puberulent to hispid (or densely villous), tips (acuminate) acute to obtuse-apiculate, bases long-attenuate into indistinct, clasping **petioles; stipules** absent; **stems** terete to deeply grooved, tough, up to 1 cm in diameter below, yellow-green to deep reddish-brown

toward the base, puberulent to retrorsely villous or hispid, erect-ascending up to 1.2 (1.6) m; **root system** a stout, annual taproot with strong lateral branches (2n = 24).
Infraspecific Variation: Densely gray-pubescent plants with tufted basal rosettes of leaves and deeply cleft petals are called ssp. *racemosa* (Otth in DC.) Gräbn. A few specimens from New York fit this category. American authors have shown considerable inconsistency in treating *S. dichotoma*, often confusing it with *S. gallica* L. There are conflicting statements as to whether the petals are entire, notched or deeply bifid, and this character is sometimes used in keys, perhaps unwisely, since it seems variable (at least in weedy North American materials). In Europe, where the diversity of characters and species is much greater within the genus, *S. dichotoma* is separated from *S. gallica* on the basis of its glabrous, longer carpophore and seeds over 1 mm long.



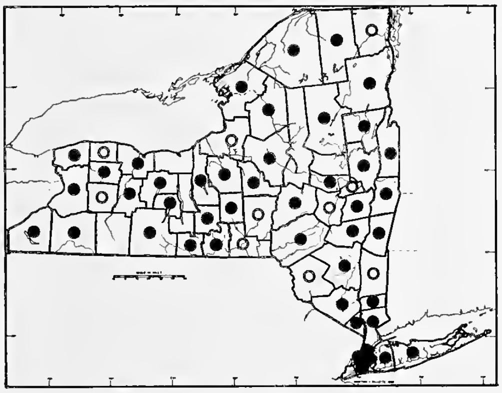


8. *Silene noctiflora* L.
Common Names: Night-flowering Catchfly or Campion, Sticky Campion or Cockle
Type Description: Linnaeus, Species Pl. I, p. 419, 1753
Synonym: *Melandrium noctiflorum* (L.) Fries
Origin: A native of Eurasia
Habitats: Cultivated fields, pastures, roadsides, waste places, meadows, clearings, often in dry, sandy or rocky soils
Habit: Erect, annual (or winter-annual) herbs
Flowering: June-September (night-flowering)
Fruiting: July-December
General Distribution: Sporadic, from Newfoundland to the Yukon, south to California and Louisiana
Description: Plants with **bisexual** flowers (opening primarily at night); **stigmas** 3 (4), papillose, somewhat flattened; **styles** 3 (4), 4-8 mm long, linear; **ovary** 1, ovate, borne on an androgynophore, ca. 1 mm long; **fruit** an ovoid capsule, 1.4-1.9 (2.3) mm long, 7-12 mm broad, the surface tan, glossy, dehiscing at the apex by 6 (-8) acute, moderately reflexed valves 2-3 mm long, borne on a stout carpophore 1-2 (3) mm long; **seeds** 1.0-1.3 mm long, ca. 1 mm broad, plump, ovoid-lenticular or trapezoidal and shallowly indented on the sides and dorsal surface, brown turning dark gray-brown, the blunt tuberculae with darker tips; **stamens** 10; **anthers** golden, dorsifixed, 1.6-1.8 mm long, ca. 0.8 mm broad; **filaments** 1.6-2.5 mm long, linear; **perianth** of 2 whorls; **petals** 5, white, pink or creamy-yellow tinged, the pale claw 1.7-2.2 (2.8) mm long, slightly exceeding the calyx tube, ca. 1 mm broad below, flared above into lateral auricles ca. 1 mm long and broad, the petal limb 6-10 (14) mm long when expanded (only in pale light or darkness) creamy at base, pinkish-tinged toward the narrowly-rounded, deeply-bifid tips, ligulate, with 2 short, coronal appendages at the limb/claw juncture; **sepals** 5, the lobes 3-8 (11) mm long, linear-cuspidate, viscid, glandular and abaxially hispid, adaxially minutely woolly, the margins often hyaline,

calyx tube cylindric in flower, tapering toward the tip, becoming fusiform and constricted above the developing fruit, and finally ovate, closely conforming to the outline of the mature fruit and almost equalling it, 0.9-2.2 mm long, 7-13 mm broad, 10-veined, the veins prominent, glandular-hispid, green with pale, whitish to hyaline zones between them that are largely glabrous; **pedicels** stout, (2) 5-12 (28) mm long, hispid and glandular-pubescent; **inflorescences** terminal (sometimes paired) cymes (dichasia), often of several 3-flowered units; **bracts** green, linear to lanceolate, glandular and hispid, 2-8 mm long subtending the flowers, up to 2.5 cm subtending the inflorescence; **leaves** (linear) lanceolate, lance-elliptic or oblanceolate to broadly ovate, obovate or spatulate, 2-12 (14) cm long, 0.4-5.5 (7) cm broad, strongly 3- to 5-veined from the base, strongly glandular-hispid to weakly strigose, margins entire, tips acuminate to acute or obtuse-apiculate, bases obtuse, acute or narrowly attenuated into **petioles**, especially on basal rosette leaves (when present); **stipules** absent; **stems** stout, terete to strongly grooved, glandular and hispid throughout, up to 60 (90) cm tall; **root system** a stout, annual taproot with strong, lateral branches (2n = 24).

Infraspecific Variation and Hybridization: Plants of this species are sometimes confused with the white campion (*S. latifolia* Poir.), but they may usually be distinguished by their linear-caudate calyx lobes, 3 styles and 6-valved capsules; however, a few New York specimens were found that seem to represent intermediates. These plants have intermediate length calyx lobes that are not strongly viscous, 4 styles and 7-9 capsule valves. Attempts to produce hybrids between these two species in the greenhouse have been unsuccessful (Prentice, 1978), and a reported cross of *S. noctiflora* and *S. dioica* L. is also suspect according to McNeill (1980a).

Importance: Night-flowering catchfly is a weed of grain, alfalfa, bean and mustard fields, reaching detrimental population densities in some areas of Canada and northern Europe. In areas where it is a noxious weed, it has also been found to be resistant to 2,4-D and other widely-used herbicides.



9. ***Silene latifolia*** **Poir.**
ssp. *alba* (Mill.) Greuter & Burdet

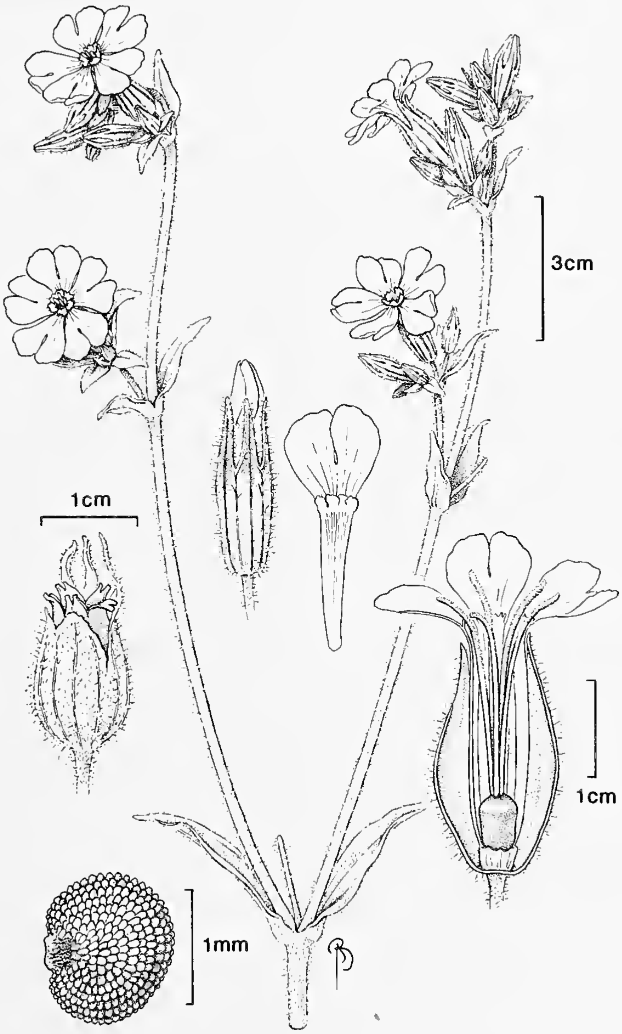
Common Names: White Campion, White Cockle, White-robin, Evening Campion or Lychnis, Snake-flower, Cuckoo-flower, Thunder- flower, Bullrattle

Type Description: Poiret, Bot. Barb. ii, p. 165, 1789

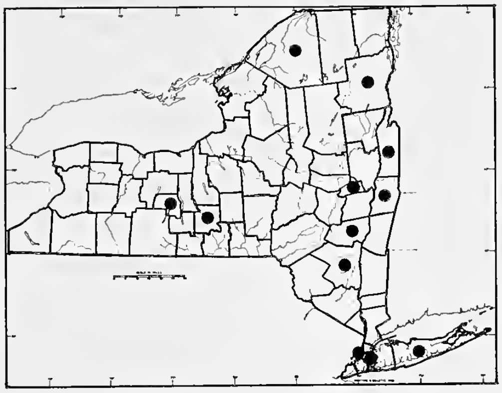
Note: To avoid confusion, some authors may wish to list this species as:
S. latifolia Poir. *non* (Mill.) Britt. & Rendle

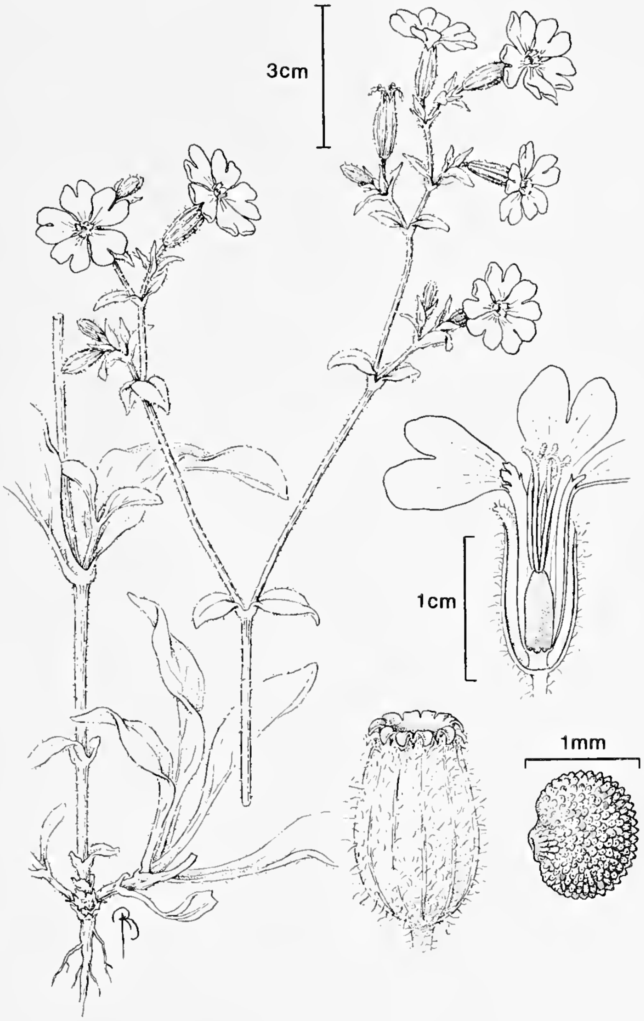
Synonyms: *Lychnis alba* Mill., *L. arvensis* Gaertn., Meyer & Scherb., *L. vespertina* Sibth., *Melandrium album* (Mill.) Garcke, *M. dioicum* ssp. *album* (Mill.) D. Löve, *S. alba* (Mill.) Krause in Sturm, not Muhl. ex Britt., *S. pratensis* (Rafn) Godr. & Gren., not Poir.

Origin: A native of Eurasia



Habitats: Fields, ditches, roadsides, urban streets and waste places, cultivated fields, meadows, thickets, borders and open woods; a ubiquitous weed
Habit: Erect or ascending, often much-branched, biennial or short-lived perennial herbs
Flowering: Late May-October
Fruiting: June-November
General Distribution: (Greenland) Nova Scotia and Quebec to British Columbia and Alaska, south to California, Illinois, Arkansas and Georgia
Description: Plants **dioecious**; **stigmas** (4) 5, densely papillose zones on the upper halves of the styles; **styles** (4) 5, linear, pale, 10-17 mm long; **ovary** smooth, green ovoid, ca. 4 mm long, 3 mm broad, subsessile; **fruit** a glossy, golden-brown capsule 1.4-1.9 (2.2) cm long, 1.0-1.5 (1.8) cm broad, ovoid, subsessile, virtually filling the calyx tube at maturity and equal in length to slightly exserted, dehiscing by (8-) 10 acute teeth 1-3 mm long that are erect or moderately recurved; **seeds** plump or with concave sides, 1.1-1.3 mm long, brown with obtuse to acute tubercles; **stamens** 10; **anthers** creamy, linear, ca. 1.5 mm long; **filaments** slender, 1.4-2.3 cm long; **perianth** of 2 whorls; **petals** white (or pink-tinged), claw 1-2 cm long in male flowers, up to 3 cm in females, slender, auriculate, not strongly exserted, petal limb 0.8-1.6 cm long, ca. half as broad, bifid with obtuse lobes; **sepals** 5, lobes obtuse to acute (acuminate) ovate to lanceolate, 3-8 (10) mm long, short-hispid, often glandular pubescent, usually with a strong, central vein, calyx tube (female flowers): 1.8-2.5 (3) cm long, ovate-cylindric becoming ovoid in fruit, up to 1.7 cm broad, veins up to 20, (male flowers): tube cylindric to narrowly ovoid, 0.8-2.1 cm long, 3-7 mm broad, hispid and often glandular-pubescent, usually 10-veined; **pedicels** 1-16 (30) mm long, those on solitary or axillary flowers usually substantially longer, sparsely to densely hispid, often glandular-pubescent; **inflorescence** a few to many-flowered dichasium, much branched on the male plants with copious clustered bracts; **inflorescence bracts** leaf-like, up to 3 cm long, those directly subtending the flowers deltoid to ovate, acute, 1-6 mm, mostly 2-4 times as long as broad, hispid, often glandular; **cauline leaves** lanceolate to broadly elliptic or obovate with acute to acuminate (rarely obtuse) tips and rounded to attenuated clasping bases, 2-9 (11) cm long, 0.5-2.5 (3) cm broad, entire, pustulate-puberulent to short-scabrous or downy-hispid when young; **basal leaves** of the first year rosette similar to cauline leaves but often obovate with more attenuated bases; **petioles** absent or some leaf bases long attenuated; **stipules** absent; **stems** terete or grooved, hispid, often glandular-pubescent, particularly above, up to 8 dm (1 m) tall, branching sparingly in female plants, but sometimes profusely in the males; **root system** a tough, biennial (rarely annual or perennial) taproot or twisted semi-erect rootstock (2n = 24).
Infraspecific Variation and Hybridization: Although they have sometimes been placed in separate genera, *Silene noctiflora* and *S. latifolia* (often called *Lychnis alba*) have parallel morphology, even though they have been placed in different sections of the genus; they have the same chromosome number; however, greenhouse attempts at crossing them have failed. Seed characters are usually distinctive, while other commonly cited morphological differences, such as glandularity, bract shape and flower color prove less reliable in distinguishing these taxa. Style and capsule tooth numbers are directly linked with sexually dimorphic versus bisexual flowers, and have been afforded great significance by some authors. Dioecious, day- and evening-flowering plants of this species complex (*e.g.*, *S. latifolia* and *S. dioica* in our area) have 5 styles and ± 10 capsule teeth, while late-evening and night-flowering *S. noctiflora* plants have bisexual flowers with 3 styles and 6 capsule teeth. This is not a clearcut distinction, however, since plants of intermediate morphology have been noted in which the style number is 4, and capsule teeth number 7-9. Capsule teeth also often bear sutures in excess of the number expected for the species, and when these become involved in dehiscence, the exercise of counting teeth becomes suspect. To further complicate matters, putative *Silene dioica* x *latifolia* hybrids have been reported, both in Europe and within our range in New York State. Occasional pink flower color in white campion and white-flowered sports of the red campion also serve to confuse the picture.
Importance: This species can be a noxious weed of crop fields.





10. *Silene dioica* (L.) Clairv.

Common Names: Red Campion, Red Bird's-eye, Red-robins, Soldiers, Adder's-flower, Devil's-flower

Type Description: Linnaeus, Species Pl. I., p. 437, 1753

Synonyms: *Lychnis dioica* L., *L. diurna* Sibth., *Melandrium dioicum* (L.) Coss & Germ., *M. rubrum* (L.) Garcke

Origin: A native of Eurasia

Habitats: Cultivated fields, roadsides, gardens, waste places, meadows and borders

Habit: Spreading to erect, perennial herbs (sometimes biennial or short-lived)

Flowering: Late May-October

Fruiting: June-November

General Distribution: Sporadically, but widely scattered from Newfoundland to British Columbia, south to Oregon, Indiana and Delaware

Distribution Note: McNeill (1978) expressed doubt that this species still occurred in eastern North America, but it was collected or reported at five locations on eastern Long Island (Suffolk Co.) as late as 1964-67.

Description: Plants **dioecious**; **stigmas** 5, papillose; **styles** 5, slender, pale, 8-13 mm long; **ovary** spherical, subsessile, ca. 3 mm in diameter; **fruit** a globose to broadly ovate, glossy, tan capsule, 9-15 mm long and broad, dehiscing by ± 10 strongly recurved teeth 3-4 mm long, often splitting further to form a gaping aperture and stretching the mouth of the calyx tube; **seeds** ca. 1 mm long and broad, plump with slightly concave side, brown with uniformly colored tubercles or tubercles with darker central papillae; **stamens** 10; **anthers** creamy yellow, ca. 1 mm long, dorsifixed; **filaments** very slender, pale, 0.8-1.7 cm long, varying in length within the same flower; **perianth** of 2 whorls; **petals** 5, deep rose to pink (rarely white), claw slender, 12-17 mm long, exserted 1-4 mm from the calyx, not strongly auriculate, the limb 8-15 mm long, ca. half as broad, usually bifid, with obtuse lobes; **sepals** 5, lobes broadly acute to rounded, 1.4-2.6 mm long, green or pinkish, hirsute, often glandular-pubescent with a weak to strong central vein, calyx tube elliptic-cylindric in flower to broadly ovoid in fruit, up to 1.5 cm long and broad, greenish with a yellowish or rosy tint, sparsely to densely hirsute, often glandular-pubescent; **pedicels** hirsute, often glandular-pubescent, 1-7 (10) mm long or flowers subsessile; **inflorescence** a sparse (female) to much-branched (male) dichasium of terminal and axillary flower clusters; **inflorescence bracts** broad, leaf-like, those directly subtending the flowers mostly 5-9 mm long, 3-6 mm broad, ovate to elliptic with acute to acuminate tips, often rosy-tinted, hirsute and glandular, particularly along the margins; **cauline leaves** narrowly elliptic to broadly obovate, mostly 2-13 cm long, 1-6 cm broad, with obtuse, acute or apiculate tips, entire margins and rounded to attenuate clasping bases, surfaces and margins puberulent to hirsute, sometimes with a few glandular hairs; **basal rosette leaves** similar to cauline leaves, but often spatulate with long petioles; **petioles** absent or obscure on upper cauline leaves to pronounced and

winged below, up to 6 cm long on basal leaves, hirsute, often glandular-pubescent; **stipules** absent; **stems** green to tan or rosy-tinted above, usually grooved, pilose to densely hirsute-glandular, spreading or erect, up to 1 m tall; **rhizomes** developing from the caudex in the second season; **root system** a first and second year taproot, adventitiously rooting from the caudex and rhizome in established perennials (2n = 24).
Infraspecific Variation: Plants of this species may rarely have white flowers. The hybrid, *Silene dioica* x *latifolia* has been reported. See also the discussion under *S. latifolia*.
Importance: These plants are uncommon and declining, mostly historically naturalized in New York State, but they sometimes become troublesome weeds in gardens and cultivated fields elsewhere.

Note: *Silen nivea* (Nutt.) Otth occurs at several sites in Pennsylvania along the New York border, and has been found once on a roadside in Sullivan Co., NY. Reports of New York State occurrences of *Silene gallica* L. [as *S. anglica* L. in House (1924) and elsewhere] were apparently based on specimens of *S. dichotoma*.

Waifs and Rare Garden Escapes: *Silene conica* L. (Suffolk, Co.); *S. italica* Pers. ssp. *nemoralis* (Waldst. & Kit.) Nyman (Washington Co.), *Silene nutans* L. (reported from Richmond Co.), *Silene virginica* L. (probably garden-grown, Yates Co.)

APPENDIX
SUPPLEMENT TO ASSOCIATED FUNGI

Since the publication of Farr *et al.* (1989), a voluminous work on fungi and their plant hosts, we have modified this appendix in the New York State Flora volumes. The following list was compiled from the mycological collections of the New York State Museum (NYS) by J. Kenneth Dean, and represents only those records not listed by Farr *et al.*

Albugo portulacae (DC.) Kuntze, on *Portulaca oleracea*, Schultz 2179
Alternaria saponariae (Peck) Neergaard, on *Saponaria officinalis*, C.T. Rogerson 9-10-62, det. Rogerson
Cladosporium herbarum (Pers.) Link ex Fr., on *Agrostemma githago*
Marssonina delastrei (DeLac.) Sacc., on *Silene vulgaris* (as *S. cucubalis*), C.T. Rogerson 9-10-62, det. Rogerson
Melampsorella caryophyllaceorum Schroet. on *Stellaria borealis*
Puccinia arenariae (Schum.) Wint., on *Arenaria stricta*, W.R. Gerard, det. House, other collections on *Spergula arvensis, Dianthus barbatus*
Puccinia mariae-wilsoni Clinton, on *Claytonia virginica*, S.J. Smith 6539, det. Rogerson, other collections on *C. caroliniana*
Uromyces verruculosus Schr., on *Silene latifolia* (as *Lychnis alba*), R. Latham 1464, det. Jackson
Ustilago violacea (Pers.) Rouss., on *Silene latifolia* (as *Lychnis alba*); S.J. Smith 42172, det. C. Rogerson; other collections on *Minuartia groenlandica*; on *Stellaria borealis*, *Stellaria longifolia* and *S. borealis* x *longifolia*

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Note: **Boldface** indicates a name used in this treatment for plants that have been reliably reported to occur in the wild in New York State.

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Community Dynamics of Small Mammals in Mature and Logged Atlantic White Cedar Swamps of the New Jersey Pine Barrens

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We dedicate this paper to the memory of Ralph E. Good for his unstinting service to the professional ecological community and for his unswerving vision of the need to understand and protect the New Jersey Pine Barrens. His presence is sorely missed.

Abstract

We examined the impacts of clear-cut logging on the composition of small mammal communities in Atlantic white cedar (*Chamaecyparis thyoides*) swamps by livetrapping small mammals in mature (60-100 years postlogging) and regenerating (6-10 years post-logging) forests. Mark and recapture techniques were used to assess population dynamics and demographic structure of small mammal species. Habitat associations were examined with multiple regression analyses of trapping frequencies and microhabitat data.

Mature cedar swamps were dominated by southern red-backed voles, *Clethrionomys gapperi*, and harbored small populations of white-footed mice, *Peromyscus leucopus*. Red-backed voles and meadow voles, *Microtus pennsylvanicus*, were nearly equal in abundance in logged swamps, which also contained small numbers of white-footed mice. Both microtines were associated with cover of low shrubs and exhibited a negative dispersion pattern relative to each other in logged cedar swamps.

C. gapperi populations on the mature forest grids had higher densities, displayed lower turnover, and supported more adults relative to juveniles (with relatively little recruitment) in comparison to populations on the logged grids. Mature cedar forests provided greater environmental suitability for red-backed voles compared to regenerating forests, which represent suboptimal habitat that appears to function largely as a dispersal sink.

The presence of mycorrhizal fungal spores in the fecal pellets of *C. gapperi* suggests that red-backed voles may play a role in the dispersal of mycorrhizal fungi that may be important for successful growth and nutrition of Atlantic white cedar.

Although *M. pennsylvanicus* may use regenerating cedar swamps only seasonally, the species nevertheless may have a negative impact on *C. gapperi* populations in logged swamps. We suggest that selective timber harvesting, in contrast to clear-cutting, might preclude colonization by *M. pennsylvanicus* by maintaining greater structural diversity in cedar swamps and by reducing the invasion of grasses and broad-leaved herbaceous species that are favored by *Microtus*.

CONTENTS

Introduction

Atlantic white cedar *(Chamaecyparis thyoides)* wetlands constitute a distinctive suite of habitats that extend from mid-Maine to mid-Florida and Mississippi in highly discontinuous patches within 200 km of the coast. The extent of these habitats has steadily diminished since the arrival of Europeans in North America, but the pace of their disappearance has become more rapid over the past several decades (Laderman, 1989). In New Jersey, Atlantic white cedar swamps are distinctive forests of the Pine Barrens with even-aged stands of tall, straight cedars and extensive mats of brilliant green sphagnum moss. Comprising only about 8,600 hectares of New Jersey's 445,000 hectares of Pine Barrens (Roman et al., 1987), Atlantic white cedar swamps are threatened habitats, having decreased in area by about 30 percent in the past 3 decades (Roman et al., 1987). Losses are linked to habitat conversion for agriculture and housing and to the combined effects of fire and logging followed by intense browsing pressure by deer which leads to the replacement of cedar swamps by hardwood swamps (Collins et al., 1988; Gould and Brown, 1961; Stoltzfus, 1990).

Although much attention has been directed toward characterizing and preserving cedar swamps, little work has examined the fauna of these habitats. Several previous studies presented anecdotal information on the species composition of small mammal communities of Pine Barrens cedar swamps (Connor, 1953, 1971; Rhoads, 1903; White, 1961) and other Pine Barrens habitats that included cedar ecotones and logged cedar swamps (Connor, 1953; Nuhn and Geller, 1983), but to date no systematic studies have been published on the small mammal communities of any Atlantic white cedar wetlands in any successional stage.

In spite of the considerable amount of research devoted to small mammal communities, relatively few studies have focused explicitly on the implications of vegetative succession for small mammal community composition and dynamics in forested habitats (reviewed by Gurnell, 1985; Kirkland, 1990). Through its drastic alteration of habitat structure, logging is clearly a major perturbation for small mammal communities (Doyle, 1990; Parmenter and MacMahon, 1983; Pearson, 1959). Increased vegetative cover following logging operations effects significant community changes in species diversity, dominance hierarchies, species composition, and population densities (Gashwiler, 1970; Kirkland, 1977; Tevis, 1956).

In an era of habitat disturbance as the rule rather than the exception in the eastern United States, it is important to look at the effects of these activities, especially in threatened environments such as Atlantic white cedar swamps. Whereas until quite recently, small mammals were viewed as destructive (or at best neutral) elements in forest ecosystems, they are now regarded as being potentially very important to forest dynamics (Maser et al., 1978a).

The study described herein examines the small mammal biota of both early successional and mature Atlantic white cedar swamps in the New Jersey Pine Barrens. The objectives of this study were to: 1) examine the impacts of clear-cut logging on the composition of small mammal communities in cedar swamps; 2) assess population structure and dynamics of species comprising these communities; and 3) characterize habitat associations of the dominant small mammal species in cedar swamps.

Methods

Site Selection

Six trapping grids were established in Ocean and Burlington counties, 3 in mature cedar swamps aged 60-100 years and 3 in regenerating cedar swamps (henceforth referred to as "logged") 6-10 years after clear-cutting. Mature cedar swamps in the Pine Barrens are second and third

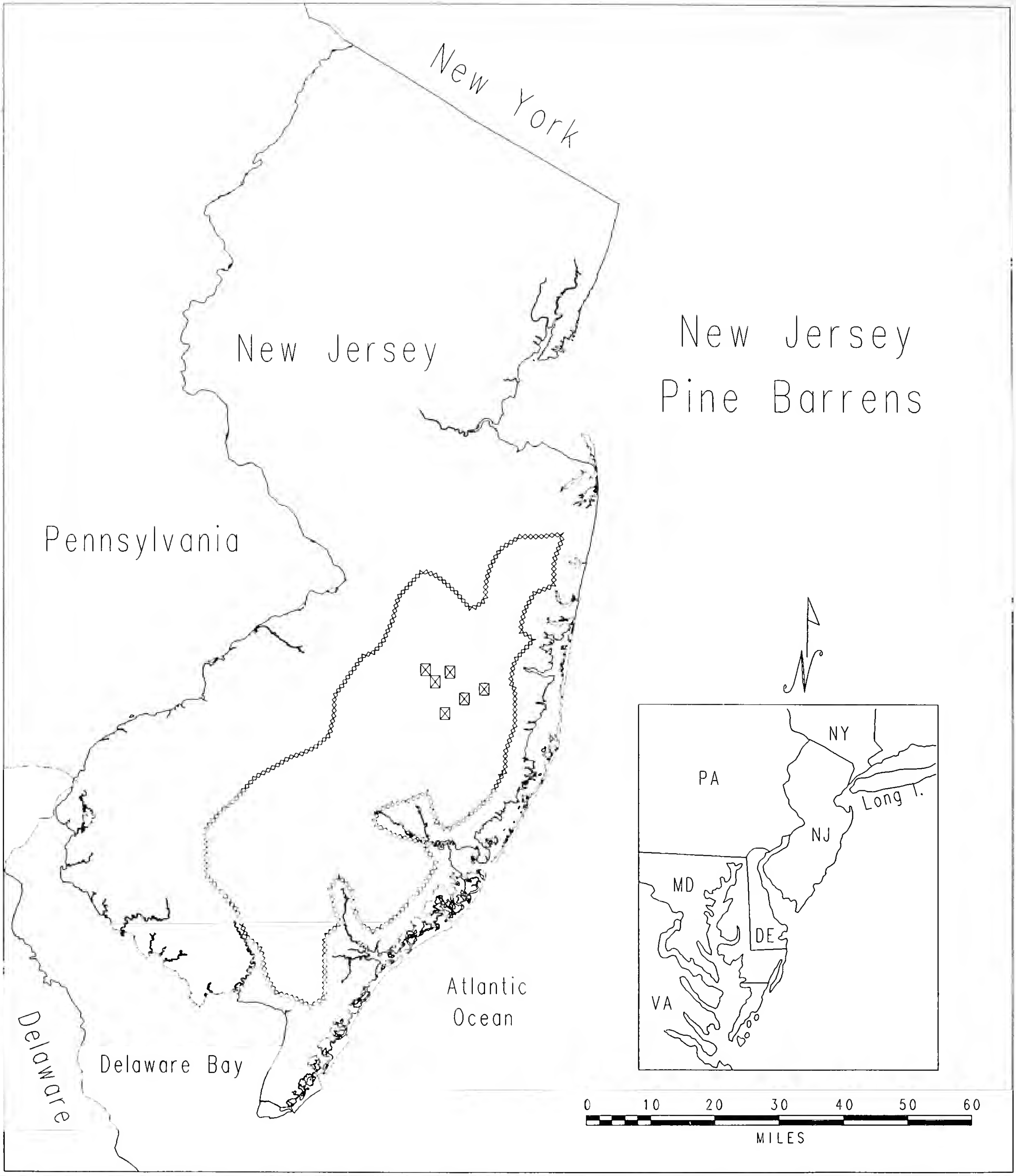


Figure 1. The New Jersey Pine Barrens area. Filled symbols indicate locations of the six small-mammal trapping grids.

growth forests; virgin stands are probably nonexistent. Writing in 1748, Peter Kalm noted that Atlantic white cedar stands had been "for the greatest part cut down" in the regions surrounding Philadelphia (Kalm, 1753).

All study sites were located (Figure 1) in the northern portion of the New Jersey Pinelands National Reserve (Good and Good, 1984). Mature sites were in Lebanon State Forest on Cooper's, Shinn's, and South Mt. Misery Branches, all in Burlington County. Logged sites were in the Greenwood Wildlife Management Area on Webbs Mill and Chamberlain Branches and at a privately owned site on Plains Branch. Cedar swamps are long, narrow habitats. We restricted the choice of study sites to swamps wide enough to accommodate grids 80 m across. Considerable effort was expended attempting to establish square-shaped trapping grids so that edge effects would be minimized.

The three mature swamps were classified as medium-sized stands (Stoltzfus and Good, 1987). All mature sites had a few hardwoods present in the canopy, which included *Acer rubrum* (red maple), *Nyssa sylvatica* (black gum), and *Magnolia virginiana* (rosebay magnolia). Shrub layers were dominated by *Clethra alnifolia* (sweet pepper bush), *Vaccinium corymbosum* (high bush blueberry), and *Gaylussacia frondosa* (dangleberry). Herbaceous plants were distributed sparsely in mature cedar swamps; the most frequently encountered herbs were two species of *Carex* (sedges) and *Mitchella repens* (partridge berry).

Selection of logged sites was facilitated by aerial photographs provided by the New Jersey Pinelands Commission. Logged sites were characterized by extensive shrub cover and had similar water table levels. Shrub layers were dominated by *G. frondosa*, *V. corymbosum*, *Kalmia angustifolia* (sheep laurel), and *Chamaedaphne calyculata* (leatherleaf). Herbaceous plants were abundant at logged sites and were dominated by *Carex* species and grasses.

Sampling Methods

Each site was sampled five or six times at three- to six-week intervals between 18 June and 7 November 1987. Each trapping grid consisted of 80 stations spaced 10 m apart, with a single Sherman live trap placed within one m of each station marker. Traps were set for three consecutive nights between 1600 and 1900 hours, and checked the following morning beginning at 0700. Traps were baited with a mixture of sunflower seeds and rolled oats, with the proportion of sunflower seeds increased gradually as the weather grew cooler. Polyester fiber bedding was also placed in the traps during cool weather to minimize trap deaths.

Newly captured rodents were either toe-clipped or ear-tagged with monel fingerling tags. Species, age class, breeding condition, sex, weight, and identification number were recorded at each capture, as were any unusual marks, conditions, or behaviors. Problems with tag loss led to the practice of toe-clipping each animal that appeared to have lost a tag. The identities of animals that were re-marked in this manner were established by matching previous records for trapping stations, sex, and weight class with the re-marked animal's data. Vegetation composition was analyzed in 40 plots on each of the trapping grids by sampling every other trapping station in a staggered configuration. Species frequency and percent cover were measured using a 0.25 m^2 quadrat gridded in 0.01 m^2 squares. By moving the quadrat successively in a straight line until 4 consecutive quadrats had been sampled, a 1.0 m^2 sample for each plot was taken.

Percent cover for each species was recorded, with shrub cover divided into above (>1.5 m) and below (<1.5 m) fractions. Canopy coverage was recorded subjectively by visually judging the composition of the canopy directly above the quadrat. Canopy composition was classified as cedar, cedar-maple, maple-cedar, or cedar-sourgum. Aside from sphagnum mosses, nonvascular plants were combined into a single category. *Sphagnum* moss was identified by species and also by total cover. Slash, dead roots, and stumps left from logging operations were categorized as "woody debris," as were dead roots, fallen trees, and stumps in the mature cedar swamps. Standing water and muddy areas were classified together as wet cover.

Data Analysis

Statistical tests, with the exception of the Spearman's rank correlation coefficient and the Jolly-Seber population estimates, were carried out using SAS for the personal computer (SAS Institute Inc., 1988). A comparison for the relative abundances (number of individuals captured per 100 trap nights) of small mammals by site was performed using a one-way analysis of variance (ANOVA).

An index of community similarity was calculated using Jaccard's similarity coefficient, represented by:

$$J = j/a+b-j$$

where **a** is the number of species found in habitat A, **b** is the number of species found in habitat B, and **j** is the number of species common to both habitats. This simple index (which can range from 0 to 1) roughly estimates the degree to which two habitats have species in common. This method tends to overemphasize rare species because equal weight is assigned to all species found in a given habitat, regardless of the frequency at which they are found (Southwood, 1978).

TABLE 1

Abbreviations of habitat, species richness, and rodent species variables used in stepwise multiple regression analyses and one-way analyses of variance (ANOVA)

SA:	Shrub cover above 1.5 m
SB:	Shrub cover below 1.5 m
HB:	Herbaceous vegetation cover
RH:	*Rubus hispidus* cover
YGCEDR:	Cedar (*Chamaecyparis thyoides*) seedling and small sapling cover below 1.5 m
DDWD:	Woody debris and slash cover
SPHAG:	*Sphagnum* moss cover
NONV:	Nonvascular plant cover other than *Sphagnum*
H_2O:	Wet cover: standing water, muddy areas, and partially submerged vegetation
LITTER:	Litter cover
CG:	Number of captures of *Clethrionomys gapperi*
MP:	Number of captures of *Microtus pennsylvanicus*
PL:	Number of captures of *Peromyscus leucopus*
SASP:	Number of shrub species in shrub cover above 1.5 m
SBSP:	Number of shrub species in shrub cover below 1.5 m
HBSP:	Number of herb species in herbaceous cover

Trapping stations were analyzed for 10 habitat variables derived from percent cover values for vegetative or environmental characteristics and thought to be significant to small mammal distributions (Table 1). Habitat variables and three plant species richness variables were analyzed for among-site differences using one-way ANOVA. Due to high overlap of shrubs at logged sites, the variable SB was truncated at 100 percent cover. All percentage values were arcsine transformed before being analyzed because many of the mean percent values for shrub and herb cover fell above 70 percent.

Habitat preferences of small mammals were assessed with stepwise multiple regression (Crowell and Pimm, 1976; Dueser and Porter, 1986). Correlation coefficients were derived from the frequency of capture of each species per trapping station and their corresponding habitat variables. Because separation of environmental variables from interspecific interaction gives an incomplete picture of habitat preference, a second set of regressions was computed that included capture frequency for nonconspecific rodents (potential competitor species, not including shrews) per trapping station as additional independent variables (Crowell and Pimm, 1976; Porter and Dueser, 1982). The frequency of capture per species included multiple captures of individuals. Data from shrew captures were not included in any of the multiple regression analyses.

Animal populations were estimated by direct enumeration (minimum number known alive or MNKA; Krebs, 1966), and by the Jolly-Seber method (Caughley, 1978; Jolly, 1965). Although results obtained with MNKA often compare favorably with those derived from the Jolly-Seber method (Boonstra, 1985), the latter method becomes unreliable when animal populations are very small (Arnason and Baniuk, 1979). Hence, we opted to use the more conservative estimator, MNKA per trapping session, in our statistical analyses of small mammal populations, with the knowledge that these estimates are likely to underestimate population sizes (Montgomery, 1987). Relative abundances were also calculated for comparison with similar studies.

Demographic structure and population means were compared nonparametrically using Kruskal-Wallis and Wilcoxon signed rank tests (Sokal and Rohlf, 1981) followed by Q-tests for multiple comparisons (Zar, 1984) when significant differences between means were found. Due to a high level of trap disturbance caused by raccoons at the Mt.

Misery mature site, population comparisons between logged and mature swamps were analyzed for *C. gapperi* with this site excluded. *P. leucopus* and *S. cinereus* appeared to be unaffected by trap disturbance.

Dispersion patterns of small mammals on grids were examined by comparing capture frequencies with Poisson distributions. The test statistic (s^2/x) was used to determine the degree of dispersion versus contagious distribution (Zar, 1984).

Interspecific association between *Microtus pennsylvanicus* and *Clethrionomys gapperi* was analyzed using Spearman's rank correlation coefficient (see e.g., Fulk, 1972) and Wilcoxon's signed rank test (Zar, 1984).

Results

Community Composition

Trapping effort for the study totaled 7133 trap nights, with 1582 small mammal captures (Table 2). On logged grids the mean relative abundance for all species combined was 50.2 individuals/ha per 100 trap nights compared with 40.1 individuals/ha per 100 trap nights at mature sites, but the difference was not statistically significant ($P > 0.40$).

Clethrionomys gapperi (southern red-backed vole) was the most abundant small mammal species in all mature swamps and in two of the three logged cedar swamps, comprising 60 percent of the 427 individual rodents captured on the six trapping grids (Table 2). Eighty percent of the individual rodents captured in mature swamps and 48 percent of all individual rodents captured in logged swamps were *C. gapperi*. *Microtus pennsylvanicus* (meadow vole) was the second most common species on logged grids, comprising 38 percent of all individuals captured there. Both habitat types supported small populations of *Peromyscus leucopus* (white-footed mouse), which was the second most abundant species at mature sites, comprising 20 percent of the rodents captured. *P. leucopus* was the third most abundant species at logged sites and comprised 12 percent of the individual rodents captured.

Sorex cinereus (masked shrew) occurred both on logged and mature sites, comprising seven percent and two percent of all captures on logged and mature grids, respectively. *Blarina brevicauda* (northern short-tailed shrew) was found infrequently, and accounted for less than one percent of all captures. Other species captured in small numbers (< 1 percent) included *Zapus hudsonius* (meadow jumping mouse) and *Synaptomys cooperi* (southern bog lemming). Other species known to be present on the grids but only captured incidentally were *Glaucomys volans* (southern flying squirrel, four individuals captured) and *Mustela frenata* (long-tailed weasel, two individuals captured) at both logged and mature swamps. *Tamiasciurus hudsonicus* (red squirrel) was observed in mature cedar swamps but was not captured.

The Jaccard coefficient of similarity for small mammal assemblages between logged and mature sites was 0.78, with logged and mature sites sharing seven out of nine species. Logged sites tended to have more species than mature sites (ranging from four to seven), while mature sites never had more than five.

Population Densities

The number of individual *C. gapperi* found in mature swamps averaged 22.9 per ha (range 5.2 to 60.0 per ha) for the 3 mature grids combined, and 31.0 per ha (range 15.7-60.0 per ha) for Shinn's and Cooper's alone (Table 3). *C. gapperi* abundance at Shinn's and Cooper's Branches did not differ ($P > 0.05$). Populations at both sites appeared significantly larger than at Mt. Misery ($P < 0.05$), but extensive trap interference at the latter site contributed greatly to this apparent difference. Hence, Mt. Misery data were excluded from all of the following analyses involving microtines.

Population levels of *P. leucopus* were similar ($P > 0.05$) at Shinn's Branch and Mt. Misery Branch, both of which were significantly larger ($P < 0.05$) than populations of *P. leucopus* at Cooper's Branch. Only two *P. leucopus* were captured at Cooper's Branch, and averaged 1.2 individuals per trap session. At Shinn's and Mt. Misery, the average number of individuals was 4.8 and 5.0 per trapping session (Table 4).

Population densities of the three most abundant rodent species exhibited apparent but statistically marginal trends ($0.05 < P < 0.10$) among the three logged sites. For *M. pennsylvanicus*, the largest populations occurred at Webbs Mill and Chamberlain Branch, followed by Plains Branch, and ranged up to 41.4 individuals per ha (Table 5). For *C. gapperi*, the largest populations occurred at Chamberlain Branch, followed by Plains Branch and Webbs Mill, achieving densities of up to 48.6 per ha (Table 3). *P. leucopus* populations appeared

TABLE 2

Total number of individuals captured, and total number of captures (in parentheses). Shrews are represented only by total number of captures.

	Rodents				Shrews			Totals
Mature grids	Cg	Mp	Pl	Sy	Zh	Sc	Bb	
Cooper's Branch	66 (207)	0 (0)	4 (9)	0 (0)	0 (0)	(2)	(1)	70+ (219)
Shinn's Branch	44 (208)	0 (0)	11 (69)	0 (0)	1 (1)	(6)	(0)	56+ (284)
*Mt. Misery	19 (44)	0 (0)	17 (48)	0 (0)	0 (0)	(4)	(6)	36+ (102)
Total:	129 (459)	0 (0)	32 (126)	0 (0)	1 (1)	(12)	(7)	162+ (605)
Logged grids	Cg	Mp	Pl	Sy	Zh	Sc	Bb	
Chamberlain	66 (206)	38 (119)	6 (22)	0 (0)	1 (1)	(14)	(4)	111+ (366)
Webbs Mill	24 (91)	44 (147)	11 (38)	3 (18)	2 (3)	(37)	(0)	84+ (334)
Plains Branch	38 (131)	18 (57)	14 (69)	0 (0)	0 (0)	(18)	(2)	70+ (277)
Total:	128 (428)	100 (323)	31 (129)	3 (18)	3 (4)	(69)	(6)	265+ (977)
								Grand total 427+ (1582)

Key:	Rodents	Shrews
Cg:	*Clethrionomys gapperi*	Sc: *Sorex cinereus*
Mp:	*Microtus pennsylvanicus*	Bb: *Blarina brevicauda*
Pl:	*Peromyscus leucopus*	
Sy:	*Synaptomys cooperi*	
Zh:	*Zapus hudsonius*	

* Mt. Misery data were eliminated from analysis of Cg populations (see text).

Table 3

Clethrionomys gapperi population estimates (MNKA) on mature and logged grids. Jolly-Seber estimates (J-S) + their standard errors (SE) are shown at right of the MNKA estimates. Trapping sessions with insufficient data for calculation of Jolly-Seber estimates are indicated by -.-.

Mature:

Grid	Date	MNKA	MNKA/ha	J-S	SE	J-S/ha
Cooper's Branch	06/18-06/20	14.0	20.0	12.7	0.9	18.2
	07/10-07/12	22.0	31.4	23.0	6.5	32.9
	07/30-08/01	23.0	32.9	27.5	2.5	39.3
	08/20-08/22	42.0	60.0	42.5	9.0	60.8
	10/02-10/04	24.0	34.3	44.6	38.3	63.8
Shinn's Branch	06/18-06/20	14.0	20.0	10.0	0.0	14.3
	07/10-07/12	20.0	28.6	20.0	2.7	28.6
	07/30-08/01	22.0	31.4	34.2	13.5	48.9
	08/20-08/22	28.0	40.0	34.3	6.0	49.1
	10/02-10/04	19.0	27.1	36.0	29.4	51.5
	10/30-11/01	11.0	15.7	11.0	0.1	15.7
Mean:		21.7	31.0	26.9	9.9	38.5

Logged:

Grid	Date	MNKA	MNKA/ha	J-S	SE	J-S/ha
Chamberlain Branch	07/17-07/19	8.0	11.4	7.0	0.3	10.0
	08/06-08/08	20.0	28.6	25.1	2.2	35.9
	08/26-08/28	34.0	48.6	36.0	8.3	51.5
	09/18-09/20	26.0	37.1	25.3	3.3	35.8
	10/09-10/11	28.0	40.0	35.8	9.7	51.2
Plains Branch	08/15-08/17	4.0	5.7	-.-	-.-	-.-
	09/04-09/06	10.0	14.3	10.5	2.3	15.0
	09/25-09/27	13.0	18.6	16.8	3.2	24.0
	10/16-10/18	26.0	37.1	31.0	3.3	44.3
	10/30-11/01	21.0	30.0	20.8	1.7	29.7
Webbs Mill Branch	06/28-06/30	1.0	1.4	-.-	-.-	-.-
	07/17-07/19	4.0	5.7	9.0	6.1	12.9
	08/06-08/08	7.0	10.0	9.0	0.4	12.9
	08/26-08/28	13.0	18.6	9.0	3.0	12.9
	10/09-10/11	15.0	21.4	17.1	2.7	24.5
	11/05-11/07	12.0	17.1	11.1	1.0	15.9
Mean:		15.1	21.6	16.7	2.4	23.9

TABLE 4

Peromyscus leucopus population estimates (MNKA) on mature and logged grids

Mature:

Grid	Date	MNKA	MNKA /ha
Cooper's Branch	06/18-06/20	1.0	1.4
	07/10-07/12	1.0	1.4
	07/30-08/01	1.0	1.4
	08/20-08/22	1.0	1.4
	10/02-10/04	2.0	2.8
Shinn's Branch	06/18-06/20	4.0	5.6
	07/10-07/12	4.0	5.6
	07/30-08/01	6.0	8.4
	08/20-08/22	6.0	8.4
	10/02-10/04	5.0	7.0
	10/30-11/01	4.0	5.6
Mt. Misery Branch	07/03-07/05	4.0	5.6
	07/22-07/24	5.0	7.0
	08/15-08/17	5.0	7.0
	09/04-09/06	5.0	7.0
	09/25-09/27	7.0	9.8
	10/16-10/18	4.0	5.6
Mean:		3.8	5.4

Logged:

Grid	Date	MNKA	MNKA /ha
Chamberlain	07/17-07/19	1.0	1.4
	08/06-08/08	3.0	4.2
	08/26-08/28	5.0	7.0
	09/18-09/20	1.0	1.4
	10/09-10/11	0.0	0.0
Plains Branch	08/15-08/17	4.0	5.6
	09/04-09/06	7.0	9.8
	09/25-09/27	5.0	7.0
	10/16-10/18	8.0	11.2
	10/30-11/01	7.0	9.8
Webbs Mill Branch	06/28-06/30	3.0	4.2
	07/17-07/19	4.0	5.6
	08/06-08/08	5.0	7.0
	08/26-08/28	8.0	11.2
	10/09-10/11	0.0	0.0
	11/05-11/07	0.0	0.0
Mean:		3.8	5.3

smaller at Chamberlain Branch relative to the other two logged sites, with densities at the latter two sites ranging up to a maximum of 11.2 per ha (Table 4). Population densities of *C. gapperi* and of *M. pennsylvanicus* often varied greatly among trapping sessions within grids (Tables 3 and 5).

C. gapperi populations in mature swamps were significantly larger than those found at logged sites over the duration of the study as a whole ($P < 0.05$; Table 3). *P. leucopus* populations did not differ significantly ($P > 0.10$) between logged and mature swamps (Table 4). The mean population density of *P. leucopus* in logged swamps was 5.3 individuals per ha, ranging up to eight individuals captured per session; the mean population at mature sites was 5.4 per ha, ranging up to seven individuals per session. *P. leucopus* numbers over time were more variable on logged grids, with captures dropping from a high of seven and 11 per hectare to a low of one and zero at Chamberlain and Webbs Mill Branches, respectively, during September and October (although numbers increased during September and October at Plains Branch). In contrast, *P. leucopus* numbers exhibited relatively little temporal variation on the mature grids.

DEMOGRAPHY

The relative numbers of male and female *C. gapperi* varied greatly among trapping sessions at both mature and logged sites (Table 6), but exhibited no consistent patterns either seasonally or between mature and logged grids.

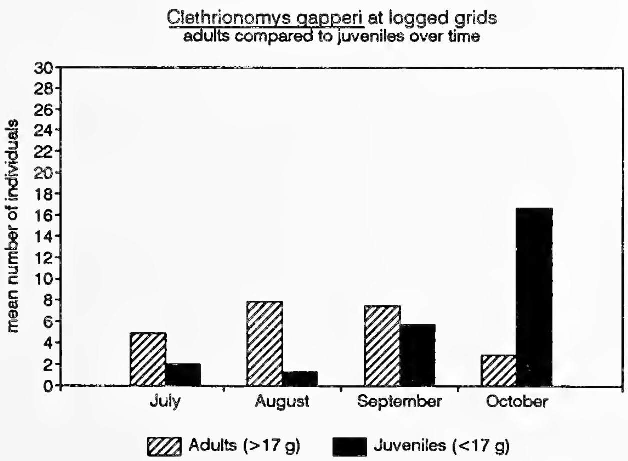
Age structure of *C. gapperi* populations between the two habitat types differed significantly. Logged sites had fewer adult animals than mature sites ($P < 0.001$) and larger numbers of subadults relative to adults, which resulted from young animals appearing during the fall. Although the differences between adult and juvenile *C. gapperi* numbers were not significant over all ($P > 0.05$), they were quite marked during September and October, when a rapid increase in subadult and juvenile numbers occurred on the logged grids, in some cases exceeding adult numbers. This increase did not occur at mature sites, where adult numbers always exceeded those of subadults. Subadult numbers in mature swamps tended to track adult numbers in times of increase or decrease (Figure 2).

The proportions of male and female *M. pennsylvanicus* varied from near equality to pronounced female bias (Table 7). Age structure was stable and

Table 5

Microtus pennsylvanicus population estimates (MNKA) on logged grids. Jolly-Seber estimates (J-S) + their standard errors (SE) are shown at right of the MNKA estimates. Trapping sessions with insufficient data for calculation of Jolly-Seber estimates are indicated by -.-.

Grid	Date	MNKA	MNKA/ha	J-S	SE	J-S/ha
Chamberlain	07/17-07/19	4.0	5.7	3.0	0.8	4.3
	08/06-08/08	14.0	20.0	12.2	0.8	17.5
	08/26-08/28	16.0	22.8	10.6	0.8	15.2
	09/18-09/20	18.0	25.7	18.4	1.8	26.3
	10/09-10/11	16.0	22.8	15.4	0.2	22.0
Plains Branch	08/15-08/17	-.-	-.-	-.-	-.-	-.-
	09/04-09/06	13.0	18.6	12.0	0.2	17.2
	09/25-09/27	10.0	14.3	10.0	3.9	14.3
	10/16-10/18	6.0	8.6	6.0	3.5	8.6
	10/30-11/01	3.0	4.3	-.-	-.-	-.-
Webbs Mill Branch	06/28-06/30	16.0	22.8	22.3	11.4	31.9
	07/17-07/19	14.0	20.0	29.6	6.1	42.3
	08/06-08/08	17.0	24.3	21.5	2.3	30.8
	08/26-08/28	29.0	41.4	48.9	17.2	69.9
	10/09-10/11	7.0	10.0	12.0	8.4	17.2
	11/05-11/07	5.0	7.1	8.0	4.9	11.4
Mean:		11.8	16.8	14.4	4.0	20.6



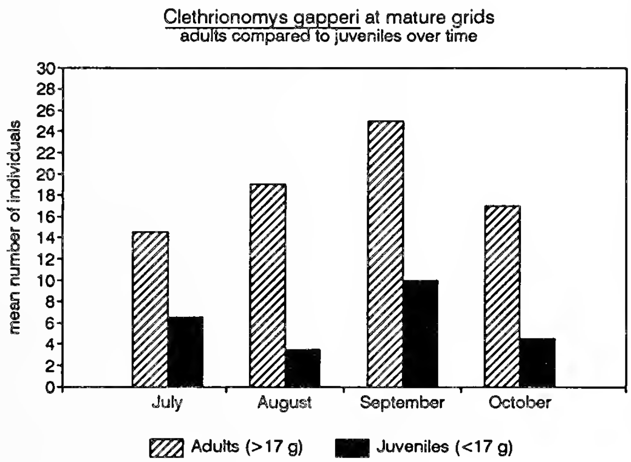


Figure 2. Mean number of individual adult and juvenile *Clethrionomys gapperi* on logged grids (top) and on mature grids (bottom)

TABLE 6

Numbers and percentages of female and male *Clethrionomys gapperi* on mature and logged grids during each trapping session.

Mature:

Grid	Date	Number of female	Number of male	Percentage of female
Cooper's Branch	06/18-06/20	8	6	57%
	07/10-07/12	17	8	68%
	07/30-08/01	9	11	45%
	08/20-08/22	15	24	38%
	10/02-10-04	10	15	40%
Shinn's Branch	06/18-06/20	4	10	29%
	07/10-07/12	11	8	58%
	07/30-08/01	12	10	55%
	08/20-08/22	10	18	36%
	10/02-10/04	11	8	58%
	10/30-11/01	6	5	55%
Chamberlain	07/17-07/19	5	4	56%
	08/06-08/08	10	11	48%
	08/26-08/28	16	20	44%
	09/18-09/20	14	18	44%
	10/09-10/11	19	13	59%
Plains Branch	08/15-08/17	3	1	75%
	09/04-09/06	7	3	70%
	09/25-09/27	9	5	64%
	10/16-10/18	12	16	43%
	10/30-11/01	6	17	26%
Webbs Mill	06/28-06/30	1	0	100%
	07/17-07/19	3	0	100%
	08/06-08/08	5	2	71%
	08/26-08/28	7	10	41%
	10/09-10/11	7	8	47%
	11/05-11/07	8	6	57%

Table 7

Numbers and percentages of each sex for *Microtus pennsylvanicus* on logged grids for each trapping session

Grid	Date	Number of female	Number of male	Percentage of female
Chamberlain	07/17-07/19	3	1	75%
	08/06-08/08	6	7	46%
	08/26-08/28	9	9	50%
	09/18-09/20	9	9	50%
	10/09-10/11	10	6	62%
Plains Branch	08/15-08/17	0	0	0%
	09/04-09/06	6	7	46%
	09/25-09/27	6	4	60%
	10/16-10/18	5	1	83%
	10/30-11/01	2	1	67%
Webbs Mill	06/28-06/30	6	9	40%
	07/17-07/19	7	6	54%
	08/06-08/08	12	7	63%
	08/26-08/28	17	16	52%
	10/09-10/11	5	2	71%
	11/05-11/07	4	2	67%

did not show the increase in subadult numbers in the fall that was seen in *C. gapperi* populations. Instead, juvenile numbers remained low throughout the study, at no time exceeding those of adults (Figure 3).

Populations of *M. pennsylvanicus* appeared relatively stable throughout the summer, followed by a decline in numbers by October. In two of the three sites, Plains and Webbs Mill, the decline was rapid, occurring within a three- to six-week period (Table 5).

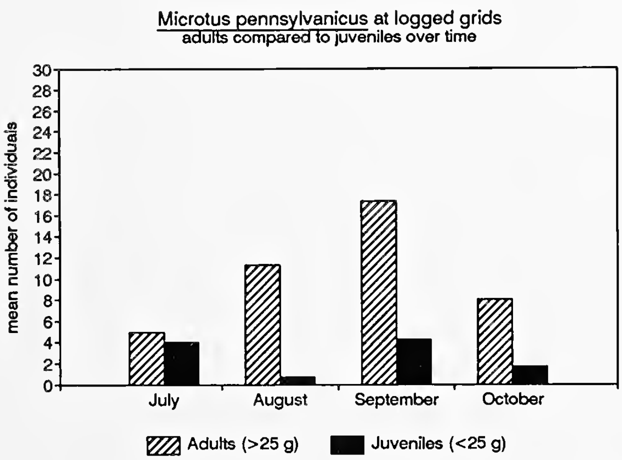


Figure 3. Mean number of individual adult and juvenile *Microtus pennsylvanicus* on logged grids

The *M. pennsylvanicus* population at Plains Branch was unique in that no individuals were captured during the first trapping session (August 15-18). Although 13 individuals were captured three weeks later during the second trapping session, only three unmarked *M. pennsylvanicus* were captured in the following session, and the population declined steadily throughout the remainder of the study. No additional unmarked animals were captured. The majority of *M. pennsylvanicus* taken at Plains Branch appeared to be young, sexually mature animals, with no individuals under 21 grams, indicating little or no reproduction at this site. A number of females in breeding condition had characteristically "fuzzy" juvenile pelage. Males, however, were mostly scrotal, and did not differ in weight at first capture from *M. pennsylvanicus* males at the other logged grids (Kruskal-Wallis $P > 0.50$).

The numbers of male and female *P. leucopus* were approximately equal, although sample sizes were small. At Chamberlain Branch, individuals were never captured for more than two consecutive trapping sessions. At Plains Branch, in contrast, 3 individuals were each caught 10 or more times over the course of 5 trapping sessions.

TABLE 8

Summary of *Synaptomys cooperi* captured on the Webbs Mill logged grid

ID Number	Sex	Weight (g) at first capture	Weight (g) at final capture	Number of captures
1339	Male	29.5	34.0	5
1345	Female	30.5	34.0	3
1346	Male	17.5	25.5	10

Synaptomys cooperi was captured only on the Webbs Mill logged grid over a period spanning nine weeks. Two males and 1 female were captured a total of 18 times. When first captured in June, the female and one male were sexually mature. By early August the immature male had descended testes and also had gained weight (Table 8). *S. cooperi* occurred over a very restricted portion of the grid, encompassing only 12 trap stations, seven of which were sampled for vegetation and habitat characteristics. *Vaccinium macrocarpon* occurred at all of these stations compared to only a 30 percent frequency at the other 33 trapping stations at Webbs Mill. Cover values for *V. macrocarpon* were significantly greater at the sites within the *S. cooperi* range on the Webbs Mill grid ($P < 0.03$). *S. cooperi* was not captured after the late August trapping session, and although runways beneath the tussocks remained abundant, the characteristic green droppings of *S. cooperi* were not observed thereafter.

Sorex cinereus and *Blarina brevicauda* were not marked individually during the study. Trap mortality was very high for both *S. cinereus* (67 percent of all captures) and *B. brevicauda* (23 percent of all captures). Hence, all insectivore data were analyzed using the cumulative captures per trapping station, and numbers of captures per trapping session. Eighty-five percent of all *S. cinereus* were captured in logged swamps, significantly more than were captured in mature swamps ($P < 0.05$). One logged site (Webbs Mill) had significantly greater numbers of *S. cinereus* than any other site, including the other two logged swamps ($P < 0.05$). Mean weights of *S. cinereus* ranged from 3.0 to 3.6 grams, and did not differ among sites ($P > 0.05$). Coat color varied from cinnamon to dark brown. Seasonal variation in the capture frequency of *S. cinereus* was evident, with 95 percent of all captures occurring after 1 August. No *S. cinereus* were captured in June, and only four captures occurred in July.

Of 13 *B. brevicauda* captures, seven were in mature swamps and six in logged swamps; thus no clear habitat preference based on habitat type was apparent. Mean weight for *B. brevicauda* was 11.9 grams (range = 9.5 to 16.0 grams). All 13 captures of *B. brevicauda* occurred between 4 September and 18 October, but there was no apparent association with cool, dry weather.

SPATIAL ANALYSIS OF SMALL MAMMAL CAPTURES

Based on capture frequencies in mature swamps, the dispersion patterns of *C. gapperi* and *P. leucopus* were nonrandom, with each species exhibiting a contagious distribution ($s^2/x > 1$; Zar, 1984). (*P. leucopus* at Cooper's Branch was not analyzed due to insufficient sample size.) Similarly, at logged sites, *C. gapperi*, *M. pennsylvanicus* and *P. leucopus* exhibited nonrandom, contagious distributions, with the one exception of *P. leucopus* at Plains Branch ($s^2/x < 1$).

INTERSPECIFIC INTERACTION AT LOGGED SITES

Capture locations for *C. gapperi* and *M. pennsylvanicus* on the logged grids give the impression of distinct clumping of one or the other species in some areas, thus implying a negative association between the two species (Figure 4). Capture frequencies of *M. pennsylvanicus* and *C. gapperi* on the logged grids are significantly negatively correlated (Table 9A) when all nonzero capture sites are used (i.e., the site has at least one capture of either species). Analysis of only those trap stations having at least three captures of one or both species ("hotspots") dramatically strengthens the negative correlation (Table 9B). The magnitude of the correlation coefficients varies with the density of *C. gapperi* on each of the logged grids. Chamberlain Branch ($r = -0.72$) had the greatest mean density of *C. gapperi* (MNKA = 23.2 per ha), followed by

Chamberlain Branch

Clethrionomys gapperi captures (o): n=206

Microtus pennsylvanicus captures (+): n=119

Plains Branch

Clethrionomys gapperi captures (o): n=131

Microtus pennsylvanicus captures (+): n=57

Webbs Mill Branch

Clethrionomys gapperi captures (o): n=91

Microtus pennsylvanicus captures (+): n=147

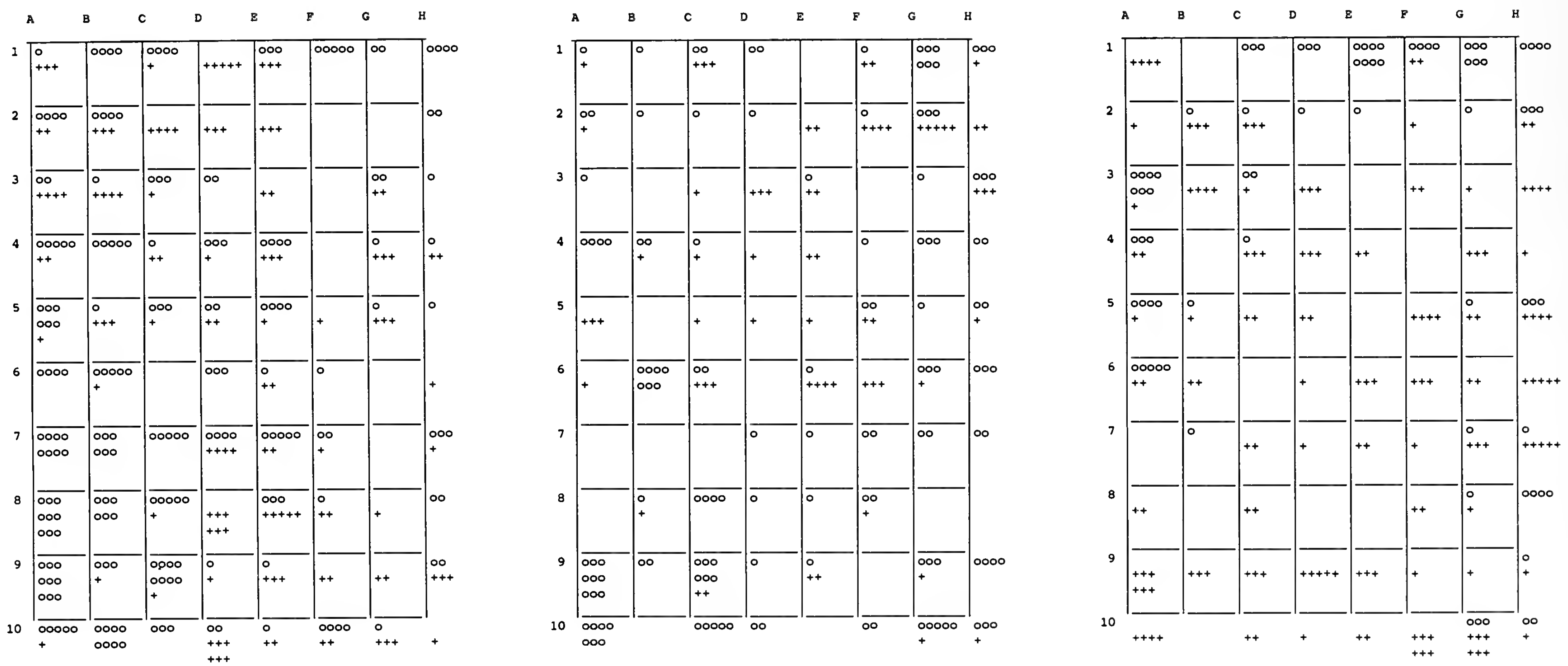


Figure 4. Distribution of captures of *Clethrionomys gapperi* ("o") and *Microtus pennsylvanicus* ("+") on the three logged trapping grids

Plains Branch (r = -0.70, MNKA = 14.8), and Webbs Mill (r = -0.63, MNKA = 8.7 per ha).

TABLE 9

Spearman rank correlation coefficients for *Clethrionomys gapperi* and *Microtus pennsylvanicus* on logged grids. Sample size reflects the number of trapping stations that had (A) one or more captures and (B) three or more captures of at least one of the two species.

A. Site	r	n	P
Chamberlain	-.43	73	<0.001
Webbs	-.22	68	<0.001
Plains	-.22	65	<0.05

B. Site	r	n	P
Chamberlain	-.72	49	<0.001
Webbs	-.63	36	<0.001
Plains	-.70	23	<0.001

HABITAT VARIABLES

Vertical shrub cover taller than 1.5 m (SA) was significantly greater at Shinn's Branch than at the other two mature sites (Table 10A). Shrub cover taller than 1.5 m was rarely found at logged sites (Table 10B). Vertical shrub cover under 1.5 m (SB) was greatest at Chamberlain Branch and at Webbs Mill ($P < 0.001$). All other sites had overlapping values, although shrub cover below 1.5 m tended to be denser at logged grids than at mature grids (Table 10B).

Herbaceous cover (HB) was significantly greater at logged sites ($P < 0.001$), with average values ranging from 23 to 60 percent. Average herbaceous cover at mature swamps ranged from 4 to 15 percent, and did not differ significantly among mature sites (Table 10C). One logged site, Webbs Mill, differed significantly from all other grids in its greater cover values of HB, and also harbored the densest population of *M. pennsylvanicus* among the three logged grids.

Litter cover (LITTER) occurred primarily in mature swamps rather than on logged grids; virtually all cover at logged sites consisted of living plants. Among mature sites, Shinn's Branch had significantly greater litter cover than Cooper's and Mt. Misery ($P < 0.001$). Hummock and hollow (submerged or partially submerged areas covered with sphagnum) formations were more pronounced at Shinn's Branch, with the hummocks being drier and supporting more litter than at the other two sites, which may account for the significantly larger litter values found at Shinn's Branch (Table 10D).

Woody debris cover (DDWD) was significantly greater at logged sites because of substantial amounts of slash left from logging operations. All mature sites had significantly lower values for DDWD when compared with logged sites (Table 10E).

Sphagnum moss (SPHAG; Table 10F) and standing water cover (H_2O; Table 10G) provide indirect measures of overall moisture levels on the trapping grids. H_2O includes areas of standing water, muddy water, and wet litter. Shinn's Branch (mature site) had the largest values for H_2O, followed by Cooper's (mature) and Plains (logged). *Sphagnum* moss was ubiquitous across all six grids, with average cover values ranging from 20 to 46 percent; although there were some significant differences, no clear pattern differentiated mature from logged sites (Table 10F). Dominant sphagnum species that occurred at both logged and mature sites were *Sphagnum bartlettianum*, *S. magellanicum*, *S. flavicomans*, and *S. torreyanum* (R. Andrus, pers. comm.).

Rubus hispidus (swamp dewberry; RH) cover was treated as a separate variable because of its potential importance as food for small mammals. The fruits of *Rubus* species are recorded as foods of *C. gapperi* and *P. leucopus* (Martin et al., 1951). *R. hispidus* cover was significantly greater at one logged site, Chamberlain Branch ($P < 0.001$), than at all other grids (Table 10H). Chamberlain Branch had the largest total small mammal population of all the sites (Table 2). Although Chamberlain Branch supported the largest *C. gapperi* population among the logged sites, it harbored the smallest *P. leucopus* densities.

Atlantic white cedar sapling/seedling cover (YGCEDR) was analyzed as a separate variable because of its importance for ecosystem regeneration (Table 10I). Cover values for cedar seedlings/saplings were significantly greater on two of the logged grids ($P < 0.001$).

Mature swamps differed significantly ($P < 0.001$) in number of shrub species among grids for SA, but not for SB. Logged grids had significantly more shrub species for SB than mature grids ($P < 0.001$). Logged grids averaged 5.0 SB species compared with an average of 3.8 SB species per mature

Table 10

One-way ANOVAs for habitat variables used in multiple regression analyses. All percentage values are arcsine transformed. Untransformed values are shown under mean %. Sample size for all ANOVAs is n=40. Significance levels are $P < 0.001$ for all ANOVAs. Grid names refer to the stream branch, e.g., Shinn's Branch, Cooper's Branch, etc.; "Chamb." refers to the Chamberlain Branch grid.

A. Shrub cover (> 1.5 m)

grid:	Shinn's	Cooper's	Misery	Chamb.	Plains	Webbs
habitat:	mature	mature	mature	logged	logged	logged
mean	1.122	0.710	0.612	0.039	0.004	0.000
Duncan's grouping						
mean %	.72	.44	.36	.02	.00	.00

B. Shrub cover (< 1.5 m)

grid:	Chamb.	Webbs	Cooper's	Plains	Shinn's	Misery
habitat:	logged	logged	mature	logged	mature	mature
mean	1.375	1.114	0.909	0.814	0.672	0.589
Duncan's grouping						
mean %	.88	.73	.57	.52	.39	.32

C. Herbaceous cover

grid:	Webbs	Chamb.	Plains	Shinn's	Cooper's	Misery
habitat:	logged	logged	logged	mature	mature	mature
mean	0.953	0.581	0.482	0.335	0.221	0.133
Duncan's grouping						
mean %	.60	.35	.23	.14	.08	.04

D. Litter cover

grid:	Shinn's	Misery	Cooper's	Plains	Chamb.	Webbs
habitat:	mature	mature	mature	logged	logged	logged
mean	0.700	0.549	0.488	0.000	0.000	0.000
Duncan's grouping						
mean %	.42	.29	.28	.00	.00	.00

E. Woody debris cover

grid:	Chamb.	Plains	Webbs	Misery	Shinn's	Cooper's
habitat:	logged	logged	logged	mature	mature	mature
mean	0.870	0.758	0.624	0.204	0.051	0.031
Duncan's grouping						
mean %	.58	.47	.38	.09	.03	.01

F. *Sphagnum* cover

grid:	Cooper's	Misery	Plains	Chamb.	Webbs	Shinn's
habitat:	mature	mature	logged	logged	logged	mature
mean	0.731	0.667	0.662	0.549	0.510	0.414
Duncan's grouping						
mean %	.46	.41	.36	.30	.28	.20

G. Open water/wet litter

grid:	Shinn's	Cooper's	Plains	Webbs	Misery	Chamb.
habitat:	mature	mature	logged	logged	mature	logged
mean	0.382	0.172	0.120	0.037	0.027	0.006
Duncan's grouping						
mean %	.22	.10	.04	.09	.09	.01

H. *Rubus hispidus* cover

grid:	Chamb.	Plains	Webbs	Shinn's	Misery	Cooper's
habitat:	logged	logged	logged	mature	mature	mature
mean	0.297	0.112	0.064	0.018	0.015	0.000
Duncan's grouping						
mean %	.17	.04	.03	.02	.01	.00

I. Atlantic white cedar sapling/seedling cover

grid:	Webbs	Chamb.	Cooper's	Plains	Misery	Shinn's
habitat:	logged	logged	mature	logged	mature	mature
mean	0.538	0.392	0.208	0.189	0.120	0.091
Duncan's grouping						
mean %	.29	.18	.09	.05	.03	.03

Table 11

One-way ANOVAs for numbers of shrub and herb species per trapping station. For all ANOVAs, n = 40, $P < 0.001$. Grid names are as in Table 10.

A. Number of shrub species per trapping station for shrubs < 1.5 m tall

Grid:	Chamb.	Plains	Webbs	Cooper's	Shinn's	Misery
Habitat:	logged	logged	logged	mature	mature	mature
Mean:	5.7	4.7	4.7	4.1	3.8	3.4
Duncan's grouping						

B. Number of shrub species per trapping station for shrubs > 1.5 m tall

Grid:	Shinn's	Cooper's	Misery	Plains	Chamb.	Webbs
Habitat:	mature	mature	mature	logged	logged	logged
Mean:	2.3	1.6	1.1	0.0	0.0	0.0
Duncan's grouping						

C. Number of herb species per trapping station

Grid:	Plains	Webbs	Chamb.	Shinn's	Cooper's	Misery
Habitat:	logged	logged	logged	mature	mature	mature
Mean:	4.4	3.9	2.8	1.8	1.7	1.5
Duncan's grouping						

grid (Table 11A, B). Logged grids supported significantly more herb species per trapping station than mature grids, with an average of 3.7 herb species compared with an average of 1.7 herb species on mature grids (Table 11C). Plant species and their frequencies on each trapping grid are listed in the Appendix.

Vegetation-Rodent Associations

At mature sites, captures of *C. gapperi* were associated significantly with only one habitat variable, shrub cover below 1.5 m (SB; Table 12A). When the effects of *P. leucopus* captures are introduced into the model, R^2 increases to 0.23, but *P. leucopus* captures were associated only weakly and negatively with *C. gapperi* captures ($P < 0.15$). In addition, SA (shrub cover above 1.5 m) becomes significant ($P < 0.08$; Table 12B).

P. leucopus captures on mature grids were negatively associated with *Sphagnum* cover (SPHAG, $P < 0.004$; Table 12A). When the effects of *C. gapperi* capture frequency are introduced into the *P. leucopus* multiple regression model, the model R improves to 0.18, with *C. gapperi* captures associated negatively with *P. leucopus* captures ($P < 0.02$).

Table 12

Habitat preferences for two rodent species on mature grids analyzed by stepwise multiple regression. Eighty trapping stations were sampled for habitat variables at all three mature grids. Partial correlation coefficients are shown for all variables with $P < 0.15$. A second model includes the influence of potential competitor species: Clga = *Clethrionomys gapperi*, Pele = *Peromyscus leucopus*. Habitat variables are as in Table 1.

A. Habitat variables only

Species:	Clga	P	Pele	P
SA	-.-	-.-	-.-	-.-
SB	0.18	0.001	-.-	-.-
HB	-.-	-.-	-.-	-.-
RH	-.-	-.-	-.-	-.-
YGCEDR	-.-	-.-	-.-	-.-
DDWD	-.-	-.-	-.-	-.-
SPHAG	-.-	-.-	-0.10	0.004
H2O	-.-	-.-	-.-	-.-
LITTER	-.-	-.-	-.-	-.-
NONV	-.-	-.-	-.-	-.-
Model R^2	0.18		0.10	

B. Habitat variables plus capture frequencies of potential competitor species

Species:	Clga	P	Pele	P
SA	0.03	0.08	-0.025	0.13
SB	0.18	0.001	-.-	-.-
HB	-.-	-.-	-.-	-.-
RH	-.-	-.-	-.-	-.-
YGCEDR	-.-	-.-	-.-	-.-
DDWD	-.-	-.-	-.-	-.-
SPHAG	-.-	-.-	-0.10	0.004
H2O	-.-	-.-	-.-	-.-
LITTER	-.-	-.-	-.-	-.-
NONV	-.-	-.-	-.-	-.-
Clga	-.-	-.-	-0.06	0.02
Pele	-0.02	0.15	-.-	-.-
Model R^2	0.23		0.18	

Table 13

Habitat preferences for three rodent species on logged grids analyzed by stepwise multiple regression. One hundred and twenty trapping stations were sampled for habitat variables at all three logged grids. Partial correlation coefficients are shown for all variables with $P < 0.15$. A second model includes the influence of potential competitor species: Clga = *Clethrionomys gapperi*, Mipe = *Microtus pennsylvanicus*, Pele = *Peromyscus leucopus*. Habitat variables are as in Table 1.

A. Habitat variables only

Species:	Clga	P	Mipe	P	Pele	P
SA	-.-	-.-	-.-	-.-	-.-	-.-
SB	0.04	0.03	0.09	0.001	—	—
HB	-0.05	0.02	-.-	-.-	-.-	-.-
RH	-.-	-.-	-.-	-.-	-.-	-.-
YGCEDR	-.-	-.-	-.-	-.-	-0.03	0.07
DDWD	-0.02	0.10	-.-	-.-	0.05	0.02
SPHAG	-.-	-.-	0.04	0.02	-.-	-.-
H2O	-.-	-.-	-.-	-.-	-.-	-.-
LITTER	-.-	-.-	-.-	-.-	-.-	-.-
NONV	-.-	-.-	-.-	-.-	-.-	-.-
Model R^2	0.11		0.14		0.08	

B. Habitat variables plus capture frequencies of potential competitor species

Species:	Clga	P	Mipe	P	Pele	P
SA	-.-	-.-	-.-	-.-	-.-	-.-
SB	0.04	0.02	0.09	0.001	-.-	-.-
HB	-0.06	0.01	-.-	-.-	-.-	-.-
RH	-.-	-.-	-.-	-.-	-.-	-.-
YGCEDR	-.-	-.-	-.-	-.-	-0.05	0.01
DDWD	-0.05	0.01	-.-	-.-	0.02	0.08
SPHAG	-.-	-.-	0.05	0.02	-.-	-.-
H_2O	-.-	-.-	-.-	-.-	-.-	-.-
LITTER	-.-	-.-	-.-	-.-	-.-	-.-
NONV	-.-	-.-	-.-	-.-	-.-	-.-
Clga	-.-	-.-	-0.05	0.007	-.-	-.-
Mipe	-0.04	0.02	-.-	-.-	-.-	-.-
Pele	-.-	-.-	-.-	-.-	-.-	-.-
Model R^2	0.21		0.19		0.08	

At logged sites, captures of *C. gapperi* were associated positively with low shrub cover (SB, $P < 0.03$) and negatively with herb cover (HB, $P < 0.02$; Table 13A). When the effects of potential competitor species are introduced into the model, the model R2 nearly doubles to 0.21, with *M. pennsylvanicus* captures associated negatively with *C. gapperi* ($P < 0.02$), and the negative association with woody debris (DDWD) statistically strengthened ($P < 0.01$; Table 13B). *P. leucopus* captures did not affect the model (Table 13B).

P. leucopus captures at logged sites were negatively associated with cedar seedling/sapling cover (YGCEDR, $P < 0.07$) and positively associated with woody debris (DDWD, $P < 0.02$). Introducing the effects of potential competitor species did not substantially alter the results of the original model (Table 13B).

Captures of *M. pennsylvanicus* were associated strongly with low shrub cover (SB) and, to a lesser extent, with sphagnum cover (SPHAG; Table 13A). Introducing the effects of potential competitor species produced a highly significant negative correlation with *C. gapperi* captures ($P < 0.007$), and the model R^2 improved to 0.19 (Table 13B).

Discussion

Community Composition

It has been suggested previously (Connor, 1953; White, 1961) that *C. gapperi* is the most common small mammal of Atlantic white cedar swamps and adjacent pitch pine lowlands in the New Jersey Pine Barrens. We found *C. gapperi* to be the most numerous small mammal species in both logged and mature cedar swamps. *C. gapperi* is rare or absent in upland areas or the Pine Barrens (Connor, 1953) and also absent from the Pine Plains (R. Unnasch, pers. comm.), an area of the Pine Barrens covered with pygmy pitch pine and scrub oak. Such a distribution is not surprising given the high water requirements of *C. gapperi* (Getz, 1962, 1968) and the distinctly desiccating environment of Pine Barrens uplands. The most striking difference we found from previous studies was the presence of *M. pennsylvanicus* at logged sites and their complete absence from mature sites. *M. pennsylvanicus* had not been documented previously in any forested wetland of the Pine Barrens.

Connor (1959) indicated that *M. pennsylvanicus* was not common in the Pine Barrens upland forested areas, being most abundant in estuarine areas near the fringes of the Pine Barrens, and in cultivated areas such as cranberry fields, where it occasionally was found in large numbers (Connor, 1953). Similarly, Connor (1971) described *M. pennsylvanicus* as abundant in shrubby, sedge-filled sphagnum bogs on Long Island, but absent from all types of woodlands, including cedar swamps. In Connor's brief New Jersey survey (1953), *C. gapperi* and *M. pennsylvanicus* were found to co-occur in spungs and other similar open wetlands. Thus it appears that *C. gapperi* in the Pine Barrens is restricted to forested wetlands (cedar swamps) and areas adjacent to cedar swamp fragments, while *M. pennsylvanicus* may be found throughout the Pine Barrens in highly localized areas of suitable habitat.

White (1961) and McManus (cited in Stiles, 1979) found a distinct gradient in the distribution of Pine Barrens' small mammals from wetlands to uplands. *C. gapperi* dominated cedar swamps, whereas *P. leucopus* dominated the drier uplands. *P. leucopus* occurred in most habitats surveyed in the Pine Barrens, with the greatest numbers found in the Pine Plains. McManus also recorded *P. leucopus* in cedar swamps, but only in very small numbers. Cedar swamps on Long Island are reportedly avoided by all mice except *P. leucopus*, which were common there (Connor, 1971; *C. gapperi* does not occur on Long Island).

Waters (1961) found *C. gapperi* inhabiting Atlantic white cedar swamps in sympatry with *P. leucopus* in coastal southeastern Massachusetts, in a ratio of approximately 1:2 in a swamp that graded from cedar to red maple at the periphery. *M. pennsylvanicus* was not found in any of the sites surveyed by McManus (op. cit.), Waters (1961), or White (1961).

The status of *Synaptomys cooperi* in New Jersey is unclear (Van Gelder, 1984), and the species has been considered periodically for investigation and protection at the state level (Kirkland, 1986; L. Niles [New Jersey Department of Environmental Protection], pers. comm.). That *S. cooperi* was found in a clear-cut cedar swamp is not too surprising, as it is known to inhabit recent clear-cuts in the Appalachians (Kirkland, 1977), as well as small openings in forests where sufficient ground cover and moisture exist (Barbour, 1956; Hamilton, 1941; Steblein, 1984). In general, *S. cooperi* prefers open areas, but in some parts of the northeast it may be found commonly in forests, as in Otsego and Schoharie Counties, New York (Connor, 1960).

All *Sorex cinereus* captured in this study tended toward rather dark pelage, and hence are presumably *S. cinereus nigriculus* (G. Kirkland, pers. comm.), the Tuckahoe masked shrew (Green, 1932), known previously only from its type locality in tidewater marsh along the Tuckahoe River in Cape May County.

Interspecific Interactions

A considerable literature devoted to interspecific competition in rodents has accumulated over the past 25 years, much of it focused on interactions between microtine species (Cameron, 1964; Danielson and Gaines, 1987a, b; Danielson and Swihart, 1987; Getz, 1985; Grant, 1978; Iverson and Turner, 1972; Rose and Birney, 1985; Turner et al., 1975) or between microtines and other more ecologically dissimilar rodent species (Grant, 1978; Heske et al., 1984; Heske and Repp, 1986; M'Closkey and Fieldwick, 1975; Ylonen, 1990). Both experimental and observational studies reveal a pattern of negative interactions between species that is temporally restricted to periods (i) during only part of the annual cycle, usually the breeding season, (ii) during periods of maximum population density in populations that undergo multiannual cycles, or (iii) during the time of year when dietary overlap is at a maximum. In many cases, priority of occupancy appears to confer a high probability of successfully remaining in that habitat in the face of potential colonization by a second species.

In North America, most species of *Microtus* occur in moist grassland habitats. Where they occur in forested areas, *Microtus* generally is restricted to clearings or other locations with grass or sedge understories (Getz, 1985). In contrast, species of *Clethrionomys* tend to occur in forested habitats, typically moist coniferous forests. In many areas of geographic overlap, wherever *Clethrionomys* occupies shrub or woodland habitats, *Microtus* tends to be limited to grasslands (Cameron, 1964; Clough, 1964; Grant, 1971; Morris, 1969). In the absence of *C. gapperi* in Newfoundland (Cameron, 1964) and on islands in southeastern Canada (Grant, 1971), *M. pennsylvanicus* is found in coniferous woodlands. Conversely, *Clethrionomys* has been found in grasslands where *Microtus* is absent (Ota and Jameson, 1961). *C. gapperi* and *M. pennsylvanicus* also have been shown to coexist during winter in grassland and in spruce forest habitats (Iverson and Turner, 1972; Turner et al., 1975), but in both cases the species occupying the atypical habitat returned to its typical habitat at the onset of the breeding season.

The two genera appear most likely to coexist in ecotonal areas with high habitat diversity or in areas undergoing succession following a disturbance (Rose and Birney, 1985). The negative interspecific association between *C. gapperi* and *M. pennsylvanicus* demonstrated in our study is likely the result both of active interspecific avoidance and microhabitat segregation. The magnitude of capture frequency correlations varied in accordance with *C. gapperi* densities at the three logged sites, which suggests an underlying mechanism of interspecific avoidance that varies with the population density of *C. gapperi*.

Microhabitat Associations

Multiple regression analyses relating habitat variables to small mammal distributions accounted for only a small portion of the variation observed in small mammal distributions, a not uncommon result. Regardless of their magnitude, certain independent variables were significant in the multiple regression analyses and may help to explain the distribution of *M. pennsylvanicus* and *C. gapperi* (Morrison et al., 1992; p. 304). Our results indicate that both species are associated with shrub cover but separate out in more open areas, with *C. gapperi* avoiding areas dominated by herbs, and *M. pennsylvanicus* tending to occur in areas with more *Sphagnum* cover. These results are consistent with the tendency of *C. gapperi* to avoid open, grassy areas and the propensity for *M. pennsylvanicus* to occur in humid, low-lying areas (Getz, 1985; Morris, 1969). The distribution of *P. leucopus* was associated with woody debris cover. Many areas with large values for DDWD contained piles of slash left from logging operations, which offered both typical cover and a vertical habitat component for the semiarboreal *P. leucopus* (Kaufman et al., 1985), which frequently is reported to be associated strongly with logging litter in forested habitats (Kirkland, 1990).

At mature sites, *C. gapperi* was associated positively with shrub cover below 1.5 m, suggesting that *C. gapperi* prefers cover in the form of low, dense shrubs. The negative association of *P. leucopus* with *Sphagnum* cover indicates that they avoid the wettest and most open areas of the mature swamps.

The second set of multiple regressions that included the additional independent variables of numbers of potential competitor species (Crowell and Pimm, 1976; Porter and Dueser, 1982) provided support for the significance of the effects of potential competitor species on the distribution of rodent species, in addition to the influence of habitat variables. Although significant, the magnitude of these effects was small, and thus constitutes only one part of a multifactorial model necessary to explain the variation in distribution patterns of these species.

One factor that makes the identification of habitat preferences of small mammals difficult is that when the population density of a competitor-species changes, habitat utilization also changes (Crowell, 1983; Crowell and Pimm, 1976; Grant and Morris, 1971). For example, Crowell (1983) found that when island populations of *M. pennsylvanicus* were large, preference for shrub versus grass habitat was affected by the presence or absence of *C. gapperi*. In years of small *M. pennsylvanicus* populations with no *C. gapperi* present, *M. pennsylvanicus* showed no preference for grassy habitats, and was instead concentrated in shrubby areas.

Territoriality, Demography, and Disturbance

A useful framework in which to evaluate the relative stability of small mammal populations among habitats is that of territoriality and the resultant demographic structure that is imposed on a population. To date, all studies of the social structure of *Clethrionomys* species indicate that females are intrasexually territorial with little or no overlap, whereas males overlap both intra- and intersexually and have home ranges that are considerably larger than those of females (Ostfeld, 1985, 1990; for *C. gapperi*, see Bondrup-Nielsen, 1986; Mihok, 1979). Territoriality and home range size in *M. pennsylvanicus* parallels that of *C. gapperi*, with females showing little intrasexual overlap in their relatively small home ranges, and males overlapping both intra- and intersexually in their larger home ranges (Ostfeld, op. cit.). Thus, there is evidence for population regulation by females in both of these microtines (Bondrup-Nielsen, 1986; Boonstra and Rodd, 1983).

Similarly, female *P. leucopus* maintain exclusive home ranges (Haigh, 1987 and references therein) that vary from one half to one third the size of conspecific male home ranges, depending upon population density (Vessey, 1987). Although there is intrasexual defense of territories in both sexes, male home ranges are less exclusive than those of females and overlap to a greater degree (Wolff et al., 1983). At low population densities, males search more actively for females, leading to larger home ranges with greater overlap (Vessey, 1987).

Demographic structure of small mammals in recently disturbed habitats such as clear-cuts and burned areas is characterized by explosive juvenile recruitment and temporal instability in density (Gashwiler, 1970; Martell, 1983; Sullivan, 1979; Tevis, 1956; Van Horne, 1981). Such habitats may function as dispersal sinks (sensu Lidicker, 1975). In contrast, populations in more stable habitats providing greater environmental suitability are themselves more stable and are characterized by higher proportions of adults relative to juveniles and by lower turnover rates (Van Horne, 1982), which can result in greater population densities.

In our study, *C. gapperi* populations averaged 22 animals per ha on the logged grids and 31 per ha on the mature grids, but reached densities of 49 per ha and 60 per ha, on logged and mature grids, respectively. Both the average and maximum densities are very large for this species; for example, a 12-year study of this species in the Appalachian Mountains of Pennsylvania reported a maximum density of only 36 voles per ha (Merritt and Zegers, 1991). McManus (based on only 700 trap nights), however, estimated 54 *C. gapperi* per ha in cedar swamps, which compares favorably with our results.

In contrast, *M. pennsylvanicus* populations in our study were comparatively small for this species. Peak populations in excess of 650 animals per ha have been recorded for *M. pennsylvanicus* in Ontario, although peak densities of 100-300 per ha are more typical in the eastern United States (Taitt and Krebs, 1985). During the present study, densities never exceeded 41 per ha, with a mean of only 17 per ha for all logged sites.

The abrupt increase in numbers of juvenile *C. gapperi* at the logged sites in autumn may indicate that logged swamps are serving as dispersal sinks for the denser and more demographically stable *C. gapperi* populations in mature swamps. The weights of the juvenile/subadult immigrants indicated they had only recently left their natal nests, and they were probably between two and four weeks old. Captive *C. gapperi* are weaned at two weeks and weigh approximately 10 grams (Innes and Millar, 1979). These values reflect the weights and characteristics of juvenile *C. gapperi* captured at the logged sites, indicating that these animals were likely to have been dispersing individuals

from surrounding mature cedar stands. The fact that fewer juvenile *C. gapperi* were captured in mature swamps indicates that little recruitment was occurring there due to the significantly larger numbers of adult *C. gapperi* present on the mature grids. Watts (1970) suggested that aggressive adult male *C. gapperi* could kill or drive out juveniles from high quality habitat.

The pronounced decline of *M. pennsylvanicus* populations at two of the three logged grids during October suggests seasonal migration from the swamps to surrounding uplands (Connor, 1959), and may have occurred partly in response to the sudden influx of dispersing *C. gapperi*. In fact, the abrupt immigration of *M. pennsylvanicus* into the Plains Branch logged grid during early September and their subsequent disappearance by the end of October suggests only an ephemeral use of logged swamps by this species. An abandoned upland field dominated by *Andropogon* grasses may have provided a source of dispersing *M. pennsylvanicus*. The field was located <1000 m from the grid, and abundant small mammal sign in the form of runways and ball-shaped nests was observed at the site.

P. leucopus densities in our study averaged between 5 and 6 individuals per ha at all sites, but ranged up to 11 per ha. These densities are similar to those reported by McManus (op. cit.) in upland areas (0.2 to 4.8 per ha, and 11 per ha in the Pine Plains) of the Pine Barrens. McManus also found *P. leucopus* in cedar swamps, but in numbers so low that no estimates could be made of population size. Populations of this species often decline sharply in late summer (Vessey, 1987), which occurred on two out of three of our logged grids, but did not occur on the mature sites. *P. leucopus* populations often undergo large intra-annual fluctuations with summer peaks; long-term studies in Ohio woodlots found within-year densities ranging from <5 per ha in early spring to >100 per ha by August, with peak populations ranging from 20-120 per ha over a 12-year period (Vessey, 1987). Thus, *P. leucopus* populations in cedar swamps are very small in comparison to those in the species' more typical deciduous woodland habitat. Populations at the logged sites fluctuated more than those at the mature sites.

Disturbance and Community Composition

Many studies of disturbances such as logging and fire in small mammal communities (Ahlgren, 1966; Cook, 1959; Gashwiler, 1970, 1972; Hooven and Black, 1976; Kaufman et al., 1983; Krefting and Ahlgren, 1974; Van Horne, 1981) have demonstrated the importance of habitat structure in determining small mammal community composition (Doyle, 1990; Parmenter and MacMahon, 1983; Pearson, 1959). For example, Ahlgren (1966) found that burning initially decreased *C. gapperi* populations in Minnesota, with reestablishment occurring only after several years when sufficient cover and food were present. Similarly, Martell (1981) found that *C. gapperi* populations declined within one to two years following clear-cutting in forests in northern Ontario. Regenerating clear-cuts in cedar swamps present obvious structural and vegetational differences compared to mature cedar swamps. Logged swamps have a dense, low shrub canopy and dense herbaceous cover while mature swamps have taller shrub canopies and sparse herbaceous cover. Our results indicate that *C. gapperi* populations in cedar swamp clear-cuts have not returned to the density and demographic structure of populations in mature sites even by 6-10 years following clear-cutting.

Kirkland (1977) found that *M. pennsylvanicus* was present in recent northern Appalachian clear-cuts and completely absent from forests 25 years or more postlogging. This was also the case in the Pine Barrens cedar swamp forests, where *M. pennsylvanicus* was found in the 6-10 year old clearcuts, but absent from the mature forests, 60-100 years post harvest. *M. pennsylvanicus* is a frequent colonist of recent (<7 years) clear-cuts (Kirkland, 1990) but presumably fails to persist as clear-cuts return to forest.

Unlike our results for Atlantic white cedar swamps, Kirkland (1990) found that *C. gapperi* increased in abundance on recent (<7 years) clear-cuts in 15 of 21 studies that he reviewed. No forested wetland sites were included among the studies reviewed.

Kirkland (1977) reported significant increases in *S. cinereus* populations at northern Appalachian logged sites, which is consistent with our results for *S. cinereus* in logged cedar swamps. Similarly, 13 of 19 studies noted increased abundances of shrews on recent clear-cuts (Kirkland, 1990), although not all species responded positively.

Microtines and Forest Regeneration

It has become increasingly evident that small mammals may play an important role in forest regeneration, and they are now regarded as being

potentially crucial to forest ecosystem dynamics (Maser et al., 1978b; Pirozinski and Malloch, 1988). Early studies of the role of small mammals in forest regeneration (e.g., Moore, 1942; Radvanyi, 1970; Tevis, 1956) tended to focus on short-term negative economic impacts. For example, voles of the genus *Microtus* in Japan are known to destroy cedar seedlings (Ota and Jameson, 1961), as has been suggested also for *M. pennsylvanicus* in the cedar swamps of the Pine Barrens (Little, 1955). More recent work, however, has demonstrated that a number of small mammal species are associated with dispersal of symbiotic species of mycorrhizal fungi, which are necessary for forest growth and nutrition (Maser et al., 1978a; Ure and Maser, 1982).

Presence of spores of a hypogeous mychorrizal fungus, *Glomus radiatum* (J. Haines, pers. comm.; Trappe, 1982) in *C. gapperi* fecal pellets from the Shinn's Branch mature grid indicates that *C. gapperi* may be important in maintaining the presence of mycorrhizal fungal symbionts of Atlantic white cedar. Hypogeous mycorrhizal fungi have been found in association with *Alnus* species growing in very boggy soils (Castellano et al., 1989), and quite possibly a similar situation exists in Atlantic white cedar swamps. Mycorrhizal associates are necessary for the normal growth of many tree species (Bidwell, 1974).

Although logging may initially increase local species diversity of small mammals (Kirkland, 1990), it can also eliminate mature forest specialists from logged areas, as has been observed for California red-backed voles (*Clethrionomys occidentalis*), Trowbridge shrews (*Sorex trowbridgii*), and northern flying squirrels (*Glaucomys sabrinus*; Tevis, 1956). In the case of *C. occidentalis*, it has been suggested that either logging or burning of forested areas can cause the disappearance of an important food source, mycorrhizal hypogeous fungi. Red-backed voles in California have been shown to be seasonal fungal specialists, and logging and burning are presumed to eliminate mycorrhizal fungi (Maser et al., 1978a, b). *C. gapperi*, however, tends to select a wider variety of foods than *C. occidentalis* (Schloyer, 1977) although its food habits in many parts of its range (including cedar swamp habitats) have not been studied in detail (Batzli, 1985).

Although relatively narrow and long, riparian habitats such as Atlantic white cedar wetlands are nonetheless very island-like (Dobkin and Wilcox, 1986), and thus present colonization and dispersal problems for their biota that differ from typical continental environments. The extent of forest fragmentation in general throughout the eastern United States further accentuates the island-like nature of these inherently discontinuous, narrow ribbons of distinctive habitat. For *C. gapperi*, clear-cutting of Atlantic white cedar forests may have the potential to eliminate this habitat specialist and preclude the possibility for recolonization.

Conclusions

Clethrionomys gapperi populations on the mature grids had higher densities, displayed lower turnover, and supported more adults relative to juveniles (with relatively little recruitment) in comparison to populations on the logged grids. Thus, *C. gapperi* populations on the mature grids were indicative of habitats possessing greater environmental suitability.

Clear-cut logging affects the small mammal communities of Atlantic white cedar swamps most dramatically by altering species composition during early successional stages. *Microtus pennsylvanicus* is abundant in regenerating logged swamps and *Synaptomys cooperi* is found in small numbers, but neither species is known to occur in mature cedar swamps of the New Jersey Pine Barrens. *M. pennsylvanicus* is a highly opportunistic species that successfully colonizes regenerating cedar swamps presumably in response to the increased herbaceous and shrubby vegetation afforded by clear-cut areas.

Our results indicate that *M. pennsylvanicus* may use regenerating cedar swamps only seasonally, but it nevertheless may negatively influence *C. gapperi* populations in logged swamps, as indicated by the distributions of the two species on the logged grids where they appeared to minimize their spatial overlap. In addition, *M. pennsylvanicus* reportedly (Little, 1955) can exert a long-term negative impact on cedar swamp regeneration by consuming cedar seedlings. We suggest that selective timber harvest in contrast to clear-cutting might preclude colonization by *M. pennsylvanicus* by maintaining greater structural diversity in cedar swamps and reducing the invasion of grasses and broad-leaved herbaceous species that are favored by *Microtus*.

Mature cedar swamp fragments apparently serve as source areas from which *C. gapperi* can repopulate logged cedar swamps. The linkage of

small mammals to the dispersal of mycorrhizal fungi coupled with our discovery of mycorrhizal fungal spores in the fecal pellets of *C. gapperi* suggests that it would be prudent to include refugia for *C. gapperi* in any management plan designed to foster the regeneration of Atlantic white cedar.

Appendix

Plant species frequency

	Mature grids			Logged grids		
	CO	SH	MI	CH	PB	WE
Trees/seedlings						
Acer rubrum	0.35	0.48	0.70	0.00	0.00	0.00
A. rubrum seedlings	0.73	0.93	0.53	0.90	0.53	0.50
Chaemaecyparis thyoides	1.00	0.95	0.98	0.85	0.80	1.00
C. thyoides seedlings	0.58	0.53	0.43	0.00	0.00	0.00
Magnolia virginiana	0.03	0.03	0.05	0.00	0.00	0.00
M. virginiana seedlings	0.00	0.03	0.08	0.00	0.00	0.00
Nyssa sylvatica	0.03	0.03	0.10	0.00	0.00	0.00
Pinus rigida	0.03	0.00	0.00	0.00	0.00	0.00
Sassafras albidum seedlings	0.00	0.00	0.03	0.00	0.00	0.00
Shrubs						
Amelanchier canadensis	0.00	0.00	0.00	0.28	0.00	0.00
Aronia arbutifolia	0.03	0.00	0.05	0.33	0.03	0.03
Chamaedaphne calyculata	0.00	0.00	0.00	0.83	0.38	0.45
Clethra alnifolia	0.85	0.83	0.95	0.13	0.48	0.43
Gaylussacia baccata	0.13	0.00	0.00	0.00	0.00	0.30
Gaylussacia dumosa	0.05	0.00	0.00	0.85	0.53	0.60
Gaylussacia frondosa	0.75	0.68	0.30	0.53	0.58	0.93
Ilex glabra	0.00	0.00	0.00	0.03	0.13	0.05
Ilex laevigata	0.65	0.30	0.65	0.00	0.08	0.00
Ilex opaca	0.00	0.00	0.03	0.00	0.00	0.00
Kalmia angustifolia	0.05	0.00	0.00	0.60	0.20	0.30
Kalmia latifolia	0.00	0.00	0.10	0.00	0.10	0.00
Leucothoe racemosa	0.30	0.20	0.68	0.00	0.50	0.15
Lindera benzoin	0.00	0.00	0.03	0.00	0.00	0.00
Lyonia ligustrina	0.15	0.05	0.15	0.03	0.03	0.03
Lyonia mariana	0.00	0.00	0.00	0.00	0.00	0.00
Myrica pensylvanica	0.00	0.00	0.00	0.33	0.65	0.05
Rhododendron viscosum	0.78	0.70	0.83	0.88	0.65	0.45
Rubus hispidus	0.00	0.15	0.15	0.48	0.38	0.15
Smilax laurifolia	0.00	0.00	0.00	0.00	0.03	0.00
Smilax rotundifolia	0.00	0.18	0.05	0.00	0.00	0.00
Vaccinium corymbosum	0.95	0.95	0.65	0.93	0.48	0.90
Forbs						
Aster species 1, 2, 3	0.00	0.00	0.00	0.23	0.35	0.00
Bartonia virginica	0.05	0.00	0.00	0.00	0.00	0.00

Decodon verticillatus	0.00	0.03	0.13	0.00	0.00	0.00
Drosera intermedia	0.03	0.00	0.00	0.05	0.08	0.08
Drosera filiformis	0.00	0.00	0.00	0.00	0.05	0.00
Drosera rotundifolia	0.23	0.00	0.00	0.18	0.43	0.45
Gaultheria procumbens	0.05	0.00	0.00	0.00	0.28	0.18
Mitchella repens	0.03	0.10	0.70	0.00	0.03	0.00
Polygala species 1	0.00	0.00	0.00	0.05	0.00	0.30
Rhexia virginica	0.08	0.00	0.00	0.00	0.00	0.00
Rhus radicans	0.03	0.18	0.05	0.03	0.10	0.05
Sarracenia purpurea	0.03	0.00	0.03	0.05	0.08	0.08
Trientalis borealis	0.03	0.00	0.10	0.03	0.00	0.05
Vaccinium macrocarpon	0.03	0.03	0.00	0.40	0.23	0.75
Xyris species	0.00	0.00	0.00	0.00	0.03	0.00
Grasses						
Andropogon virginicus	0.00	0.00	0.00	0.13	0.18	0.23
Panicum species 1	0.00	0.00	0.00	0.18	0.00	0.00
Sedges						
Carex collinsii	0.45	0.50	0.23	0.65	0.43	0.43
Carex trisperma	0.38	0.15	0.20	0.55	0.73	0.10
Carex species 1, 2	0.03	0.00	0.00	0.73	0.13	0.90
Eriophorum virginicum	0.00	0.00	0.00	0.00	0.05	0.15
Rynchospora alba	0.00	0.00	0.00	0.00	0.08	0.00
Ferns						
Osmunda cinnamomea	0.08	0.00	0.28	0.08	0.05	0.13
Woodwardia virginica	0.08	0.03	0.00	0.08	0.00	0.00
Woodwardia aerolata	0.03	0.03	0.10	0.00	0.00	0.00
Nonvascular plants						
Liverworts, mosses	0.98	1.00	0.98	0.00	0.00	0.00
Sphagnum bartlettianum	0.55	0.83	0.63	0.88	0.70	0.63
Sphagnum flavicomans	0.00	0.65	0.00	0.00	0.45	0.00
Sphagnum pulchrum	0.00	0.05	0.00	0.05	0.00	0.28
Sphagnum torreyanum	0.45	0.00	0.38	0.00	0.03	0.95
Sphagnum lescurii	0.00	0.38	0.00	0.00	0.00	0.00
Sphagnum imbricatum	0.48	0.03	0.70	0.00	0.00	0.00
Sphagnum magellanicum	0.25	0.60	0.10	0.83	0.33	0.68
Sphagnum angermanicum	0.00	0.00	0.00	0.00	0.03	0.05
Sphagnum unknown sp.	0.00	0.00	0.00	0.05	0.00	0.00
Total *Sphagnum* frequency	0.93	0.95	0.90	0.93	1.00	0.95
Ground cover						
litter	0.85	1.00	0.98	0.00	0.00	0.00
slash	0.08	0.48	0.08	0.93	1.00	0.90
wet cover	0.28	0.33	0.65	0.03	0.40	0.15

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